POWER

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Business Recovery and Unemployment

Happy days are ahead.

Evidences pointing definitely to the recovery of business continue to appear on the horizon. And this is as true in the power field as elsewhere.

The heads of the manufacturing companies are perking up and noses are sniffing the air with an interest and spirit born of bona-fide inquiries and orders placed. These things could not happen if the industrial outlook did not justify them. And this means business.

But no one thinks recovery will be so rapid as to lessen one whit, the plans for the winter's unemployment relief. Caring for those less fortunate than ourselves is a human problem that transcends all else.

Very few indeed but realize this and heartily subscribe to the President's plan for full help and no dole.

What better proof of this than the determination of those in authority that relief shall be provided only upon the basis of work actually performed?

Think also of the inspiring plan put into effect recently by a manufacturer of electrical apparatus whereby 2 per cent of the gross sales for five months will be returned to the locality of their origin for the relief of unemployment.

How much better life is!

EDITORIALS

Engineering Profession Has No Apologies

There has been some talk among present-day philosophers that life in the old days of slavery and treadmills must have been more satisfactory than in the so-called machine age of latter days. Since the late hiatus in the era of prosperity these same people and a few others have been advertising the theory that the engineering profession has, by its invention of labor-saving machinery and mass production, become primarily responsible for the present distressing unemployment.

Technological unemployment, they call it. Presumably those who would saddle this incubus upon the engineering profession are quite willing to return to the dark ages, when a chosen few luxuriated in leisure while thousands of human slaves bent their backs in penury to pay the price.

Contrast this with the enlightened civilization of today, when slave power has given way to machine power many times its superior in quantity and quality of service and available in factory and home at the flip of a finger.

In the last analysis, the engineering profession has made no more mistakes than others, and its contributions to the welfare of mankind are fundamental and of the first rank.

Engineers, instead of regretting, have every reason to be proud of their share in the present civilization. Admitting their work has not reached perfection, shall their efforts not be accorded the same appreciation as that given to the doctors, lawyers or other professions?

Plenty of things are not right yet, but they are being bettered. Meantime, it should be well understood that the engineering profession has no apologies to offer.

Operating—A Real Vocation

There are two kinds of power house operating men, those who look upon their work as a real vocation, and command the utmost respect from their fellow workers, and the others who think of their employment simply as a whistle-to-whistle job, and who appear to be fully interested only when off shift.

While all employers should realize that their best interests will be cared for only by loyal workers, there are, unfortunately, too many who seem to consider that it is money well saved to pinch the stipend of the power house operating man to the limit of human acceptability.

There is no denying that the march of time is gradually forcing the disappearance of the good old-fashioned man from the power house. He who was everything from fireman to master mechanic, plumber, clock repairer, and whatnot. Certainly to him his work was an integral part of his life, and no complaint was ever thought of when conditions required unstinting devotion to the job in order that the factory wheels would not stop turning.

If the present generation of younger men is to be brought into the power house life, with a genuine taste for its work, and respect for its traditions, they must receive their training at the hands of superiors who themselves are thoroughly imbued with the spirit of service, and who are aware of the perhaps intangible, but certainly invaluable, results that accrue from the recognition of operating men as the pursuers of a time-honored and highly respectable vocation and not merely as job holders.

The men will unquestionably respond to a treatment which will accord to them a genuine appreciation of their responsibilities in power house service, and the results cannot help being profitable to all concerned.

Water-Power Possibilities

So much attention has been given to first cost of power plants that engineers are prone to lose sight of other factors which may be equally important. To compare steam and hydro plants on a first-cost basis alone may lead to erroneous conclusions. The type of plant or combination of plants that will deliver power to load centers at the lowest unit cost, other conditions being equal, generally is the most desirable.

Fuel cost at steam plants and available storage for hydro plants have a marked influence on the economic relation of steam to water power. In Canada fuel costs are generally high, but water powers with large storage capacity can be developed comparatively cheaply. As a result, about ninety-eight per cent of the power generated by central stations in that country is from hydro plants. As a general proposition, fuel costs are much lower, hydro development costs are higher, and large-capacity storages are not as readily obtained in the United States as in Canada. This creates a different set of economic conditions that must be met in providing a power supply. Notwithstanding that these conditions exist, some of the largest hydro developments in the United States are made in fuel-producing regions.

Economic factors affecting steam and hydro plant construction in Europe are such as to lead to a wide use of pumped-storage hydro-electric projects, a type of installation little used in North America.

Interconnection of power systems has made it possible to utilize many water powers that could not be economically developed otherwise. On such systems large hydro-power sites frequently can be developed for either base- or peak-load service. The kind of development will materially influence the cost per horsepower. A plant for peak-load operation may have several times as much capacity installed as would be put into a base-load plant on the same site. Because of the greater capacity installed, the cost per horsepower for the short-time or peak-service plant will be lower. Consequently, the building cost per unit of capacity installed in a water-power plant is a rather uncertain quantity unless all the factors of service are considered. It may be high if a given site is developed for base-load service, or low for peak-load operation.

Hydro plants that cannot be economically built for base loads in competition with steam may often be used to provide peak-load capacity more cheaply than a fuel-burning plant. A water-power plant of this class on the system frequently makes it possible to operate the steam plant on the base load at a higher economy than if the latter were supplying the entire load. Because of the readiness with which hydro units can be put into operation, a power system having a hydro tie-in can be operated with less running reserve. These and other factors tend to lower the cost of power generation and should be included when considering hydro's place in the power field.

A.E.C. Employment Program

Employment committees of the American Engineering Council are now functioning in some twenty-odd states, a part of their program being the listing of all governmental works projects, and, where delayed, ascertaining the causes and pressing for the action to put these various relief measures into operation.

The engineering profession, through the medium of its organized societies, is eminently fitted for the task of bringing this whole subject down to earth. The plan for speeding up public works is in no sense new. In fact it was among the first of the proposed emergency measures when unemployment became evident. While a certain progress has been noticeable in the carrying out of some local public works projects, nothing approaching even the actual number of such projects for which funds have already been appropriated has reached the construction stage. This is evidenced by the fact that the amount actually expended for public buildings by the Federal Government for the fiscal year ending June 30 was only 28 million dollars. A further 38 million spent for sites did not help employment.

The engineering approach—and the American Engineering Council would naturally undertake emergency relief of unemployment as an engineering problem—calls first for the definite uncovering of all the public works programs which can immediately be initiated.

Provided that means are found to translate these efforts into action, the A.E.C. will do a great work. The danger is that this effort may be so tardy of function that it will come too late to serve this winter's necessity. Success is dependent largely upon engineers' cooperation throughout the country, and *Power* urges that this be given unstintingly, for the glory of the profession and in the interest of humanity.

Bituminous Coal Conference

The Third International Conference on Bituminous Coal, like its predecessors, had as its main purpose the collection and dissemination of the latest results of scientific studies on coal and its utilization. Coming in one of the most difficult years in the bituminous coal industry, considerable time and thought was devoted to the cause and possible cure for the troubles which beset it.

Following the lead of other basic industries, equally plagued with economic difficulties, a concerted trend toward government control and regulation as the simplest way out of the mire was apparent.

To let "Uncle Sam" or his nephews, the several states, lift from the coal industry's shoulders the responsibility for balancing its economic budget — of putting its executive house in order—appears at first glance to have beautiful possibilities. The record of government in business, however, hardly seems to bear out such expectations, and a warning to this effect was sounded by both Myron C. Taylor and Governor Ritchie of Maryland.

Certain industries having resources essential to the state may, if development has reached the point where they are stable and practically self-operative, profit to a limited extent by a measure of governmental regulation.

The bituminous coal industry, however, stands today almost on the threshold of its ultimate development. Few would be so bold as to prophesy what its position in the economic structure of the country will be ten years hence. In what does happen, however, carbonization and the extraction of basic materials, hydrogenation and the multiplicity of valuable products to be removed from primary tars will undoubtedly have their influence. Governmental control could not avoid limiting the competitive and creative forces which, will, by carrying this business forward in its natural path, be principally responsible for its future development.

As to the present, there must be within the coal industry itself a sane adjustment of production to consumption and cooperative planning for efficient production, distribution and development. If undertaken with sincerity and a frank facing of the issues, the industry will revive.

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POWER Stands for . .

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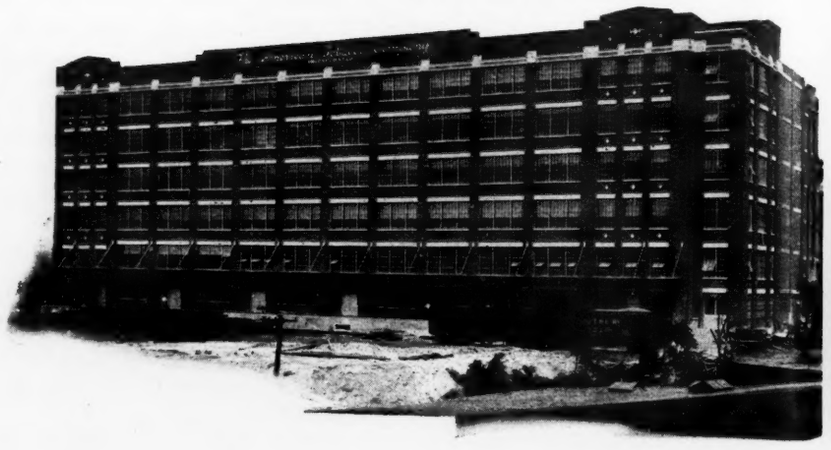
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

▼

LUCKY STRIKE FACTORY

Manufacturing one hundred million Lucky Strike cigarettes a day, the capacity of the Virginia branch of The American Tobacco Company at Richmond, Va., involves the most advanced of methods. Not only must the cigarette-production machines be keyed to the highest rate of capacity and quality, but, of equal importance, the process steam and power sources must be both economical and reliable. This was the problem confronting the management and consulting engineers when planning the power supply

View of the Lucky Strike factory and its power plant



ORIGINALLY THE American Tobacco Co. had a factory in Richmond for the manufacture of other tobacco products as well as of cigarettes. Steam needed in drying the tobacco was supplied directly from boilers, while power was purchased from the local utility. When the capacity of this plant was reached it proved desirable to construct a new factory devoted exclusively to cigarette manufacture.

Much study was devoted to the power supply problem. If power was to be purchased, and process steam obtained as before, direct from the boiler, the inherent advantage in the combination of process steam and power would not be secured. In addition generation of power in its own plant would permit the tobacco company to have complete control over all phases of the cigarette manufacturing. Data from other factories of this company indicated that the cost when steam and power were generated would be less than the cost of steam and purchased power, even at the attractive rates offered. It should be understood that the hours of factory operation, nine per day, are such that the most advantageous electric rate is not obtainable, since the connected load charge assumes a greater importance than if the plant operated continuously for 24 hours per day.

Based upon the power and steam requirements of the other factory, the probable power load of the new plant was estimated to be somewhat below 1,700 kw. at the contemplated factory output of cigarettes. The demand for steam for processing, based on the record of the other factory, was estimated 62,000 lb. per hour, average, with a maximum of 80,000 lb. in the winter and a summer maximum of 42,000 lb., with a pressure of 90 lb. gage.

It seemed highly desirable to operate the plant in parallel with the public utility, so that the latter could supply the electrical demand above the amount that could be developed by the steam going to the processes. This load swing was expected to be in the neighborhood of 500 kw. during the summer, and little, if any, during the winter, when the steam heating was added to the process load. This connection would permit the public utility to supply the energy needed at night and during the holidays. Such an arrangement was made, with the additional provision that the utility would take all the electrical load in case the power plant experienced trouble that caused complete shutdown. To insure continuity of plant and to hold down the maximum demand upon the utility in case of turbine trouble, two 1,000-kw. turbines were decided upon.

To obtain the balance of power and process with 90 lb. back pressure on the turbines, a boiler pressure of 415 lb. was needed. This would give a pressure of 400 lb. at the throttle, at which the turbine steam rate, with a total steam temperature of 600 deg. F., was guaranteed to be 40.8 lb. per kilowatt-hour at full load and 46.7 lb. at half load. This consumption would give the total amount of process steam needed.

Naturally, water-tube boilers were chosen, these consisting of three four-drum units shown in Figs. 3 and 5. Air preheaters or economizers are absent from the layout, on the basis that they are not justified in a one-shift plant when coal is available at a low price. However, the boilers have economizer sections incorporated in their design.

Since the plant was to operate only during the daytime, with one boiler carrying the night process-steam load of about 15,000 lb. per hour, most of which is the steam needed to supply the turbine driving the Carrier air-conditioning system in the factory, which runs continuously, stokers seemed more suitable than other types of fuel-burning equipment.

GETS CHEAP POWER By Combined Generation and Purchase

By L. H. MORRISON
Associate Editor of POWER

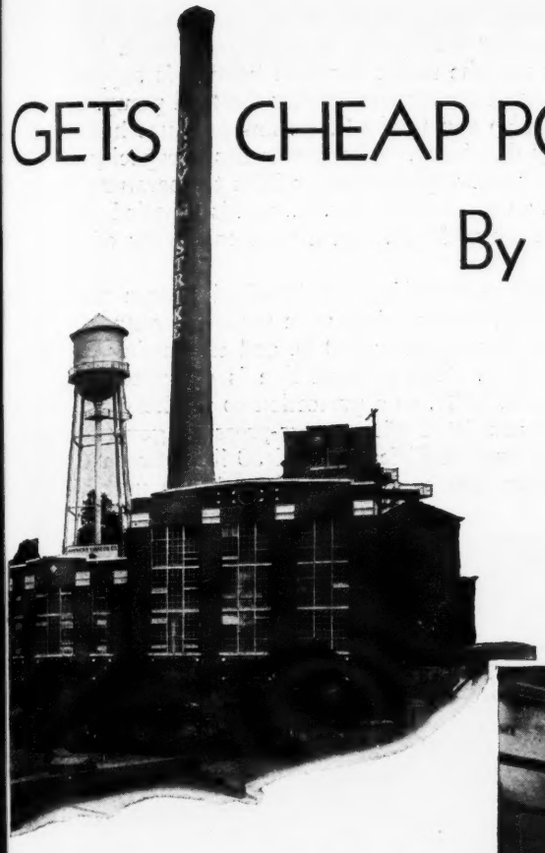


Fig. 1—The turbines rest on concrete columns, with the basement and boiler room on the same level

The boiler manufacturer guaranteed the following efficiencies:

Per Cent Rating	Flue Gas Temperature, Deg. F.	Draft Loss, In.	Efficiency
100	530	0.18	77
150	575	0.40	76.2
200	625	0.72	74.6
250	670	1.12	72.8

Basis of Boiler Guarantee, Per Cent

Rating,	CO_2	Loss Due to Unburned Carbon	Loss Due to Radiation, Etc
100	12	1.0	4.5
150	12	1.2	3.7
200	12	1.6	3.3
250	12	2.2	3.1

These are based on West Virginia slack bituminous coal, which gives the following analysis:

Heat content, dry basis, B.t.u.	14,500
Moisture, per cent	1.9
Volatile, per cent	29.8
Ash, per cent	6.0
Sulphur, per cent	0.7

The furnace air supply is furnished by forced-draft fans and the balanced-draft apparatus is actuated through change in the boiler pressure.

To handle the coal a track hopper was installed, for which the fuel is carried by an 18-in. rubber belt to a bucket elevator. This elevator is provided with two discharge gates, one leading into a tile silo and the other onto a shuttle-type belt moving along the bunker top. As the silo has a capacity of 450 tons and the bunker 500 tons, there is no danger of coal shortage. No crusher is installed, for slack is available at all times, being obtained from West Virginia mines.

Each boiler is equipped with a copper-steel ash hopper lined with vitrified shale brick, ash quenchers and chutes.

Three welded steam headers are incorporated in the plant design. One of these, placed behind the three boilers, is in two sections of 12 in. diameter. Steam from the superheaters enters this header and is drawn out to the turbines through suitable nozzles and

piping. The nozzle flanges have square lap points, leak-proof at 450 lb. pressure. Gate valves have ¼ raised serrated flange faces with nitralloy valve seats. The load on the turbine is governed by the back pressure, but each machine has, in addition, speed governors for use if needed.

Steam exhausts from the turbines at 90 lb. gage and 380 deg. F. total temperature and enters a low-pressure superheat header, out of which is taken the steam for the 330-hp. turbine driving the air-conditioning compressor.

In the factory processing, saturated steam is needed to maintain uniform drying. This prompted the employment of a desuperheater, which is placed between the low-pressure superheated-steam header and a low-pressure saturated-steam header. This header feeds four process steam lines to the factory biuldings. The desuperheater has a steel body and nickel bronze nozzles, of a size to desuperheat 90,000 lb. of steam at 100 lb. and 125 deg. superheat. Desuperheating water is supplied from the boiler-feed line at 450 lb. and 228 deg. F.

A bypass incorporating reducing valves connects the high-pressure and the low-pressure superheated steam. The bypass is provided with two reducing valves in parallel; a 3-in. valve is set to reduce from 400 to 100 lb., and if it does not admit sufficient steam the pressure in the low-pressure header drops to 98 lb., at which time a 4-in. reducing valve opens.

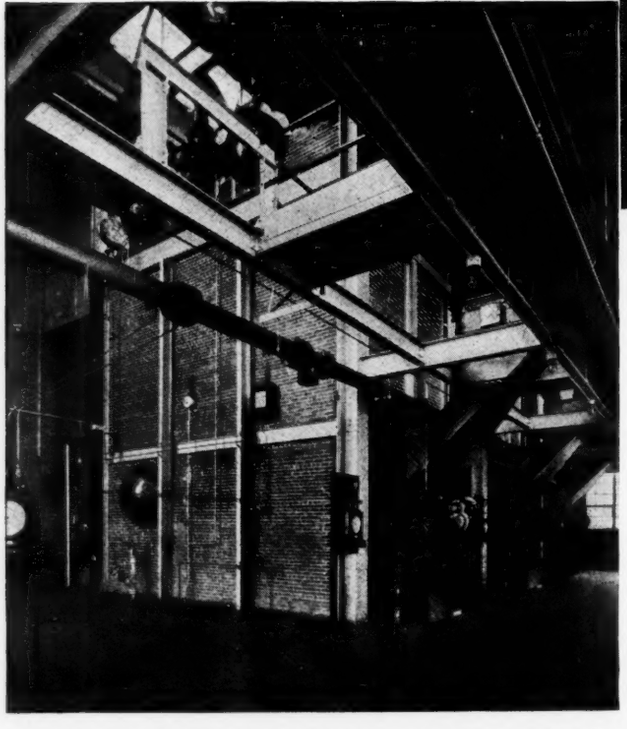


Fig. 2—Feed heater is elevated on a steel structure with the pumps on the floor beneath

An emergency bypass is provided so that steam can be taken directly from the high-pressure to the saturated-steam header. This is a connection that is used in case of trouble with reducing valves, etc.

All the high-pressure piping is of lap-welded ½-in. open-hearth steel, tested to 500 lb. hydrostatic pressure.

The returns for the factory are pumped into a horizontal heater and the steam for feed heating is supplied at 6 lb. gage from the turbine driving the feed pump. A connection is also run to the 90-lb. low-pressure header to supply any deficiency. The heater has a capacity of 140,000 lb. per hour, with a water inlet temperature of 130 deg., and an exit of 215 deg. F., and is supplied with a relief valve set at 10 lb. and a vent condenser of 20 square feet.

Two four-stage centrifugal boiler-feed pumps were installed. One is motor-driven; the second is connected to a turbine taking steam at 100 lb. and exhausting into the heater at 6 lb. The exhaust line is equipped with pop valves set at 10 lb. as a protection to the heater.

The pumps are fitted with excess-pressure governors to maintain a constant differential of 30 lb. between the pump and boiler pressures. The motor-driven unit has this governor act directly on the pump discharge, while the second pump has the governor on the steam supply to the driving turbine. Three pumps with automatic control handle the condensate from the factory for delivery into the storage tanks.

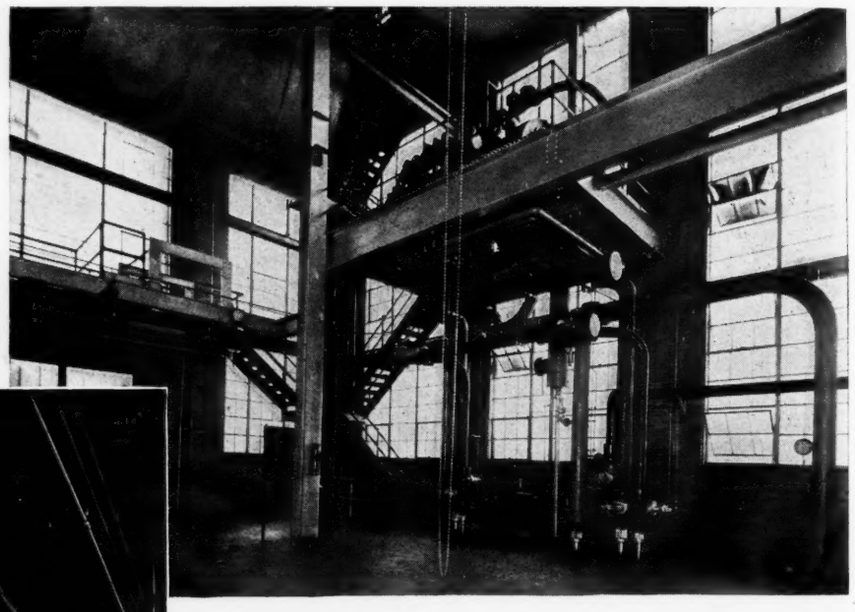


Fig. 3—Side view of one boiler and stoker

As constructed the plant is one of the most convenient in the South.

The boiler room floor is sufficiently above the ground level to permit dumping the ashes from the hopper directly into auto trucks, which enter a closed-off passage between the boiler room basement and the lower level of the turbine room.

The turbines are mounted upon a platform supported by concrete columns. Due to the absence of condensers, the space under the platform is clear, there being only the drip traps, oil coolers and ducts for the generator below the platform. The remainder of the floor is occupied by two compound compressors supplying air to the factory and by the two low-pressure headers, which are placed along the wall in an alcove formed by extending the boiler room into the turbine room. This places the high pressure header, which is back of the boilers, immediately above the low-pressure headers, but separated from them by the boiler room floor.

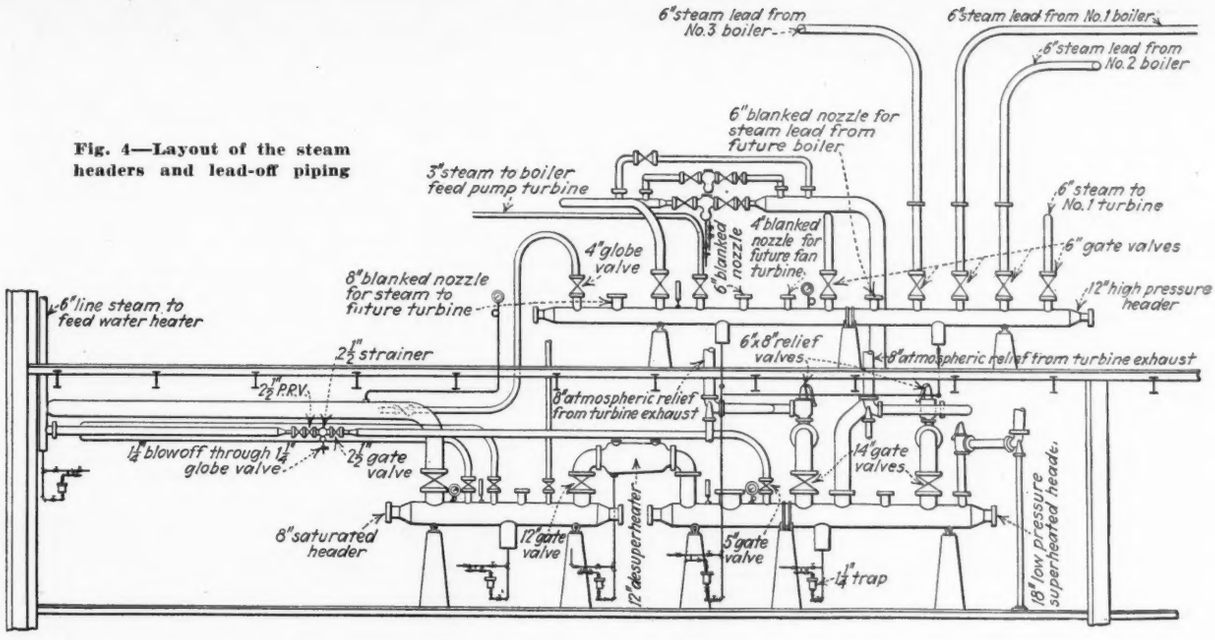


Fig. 4—Layout of the steam headers and lead-off piping

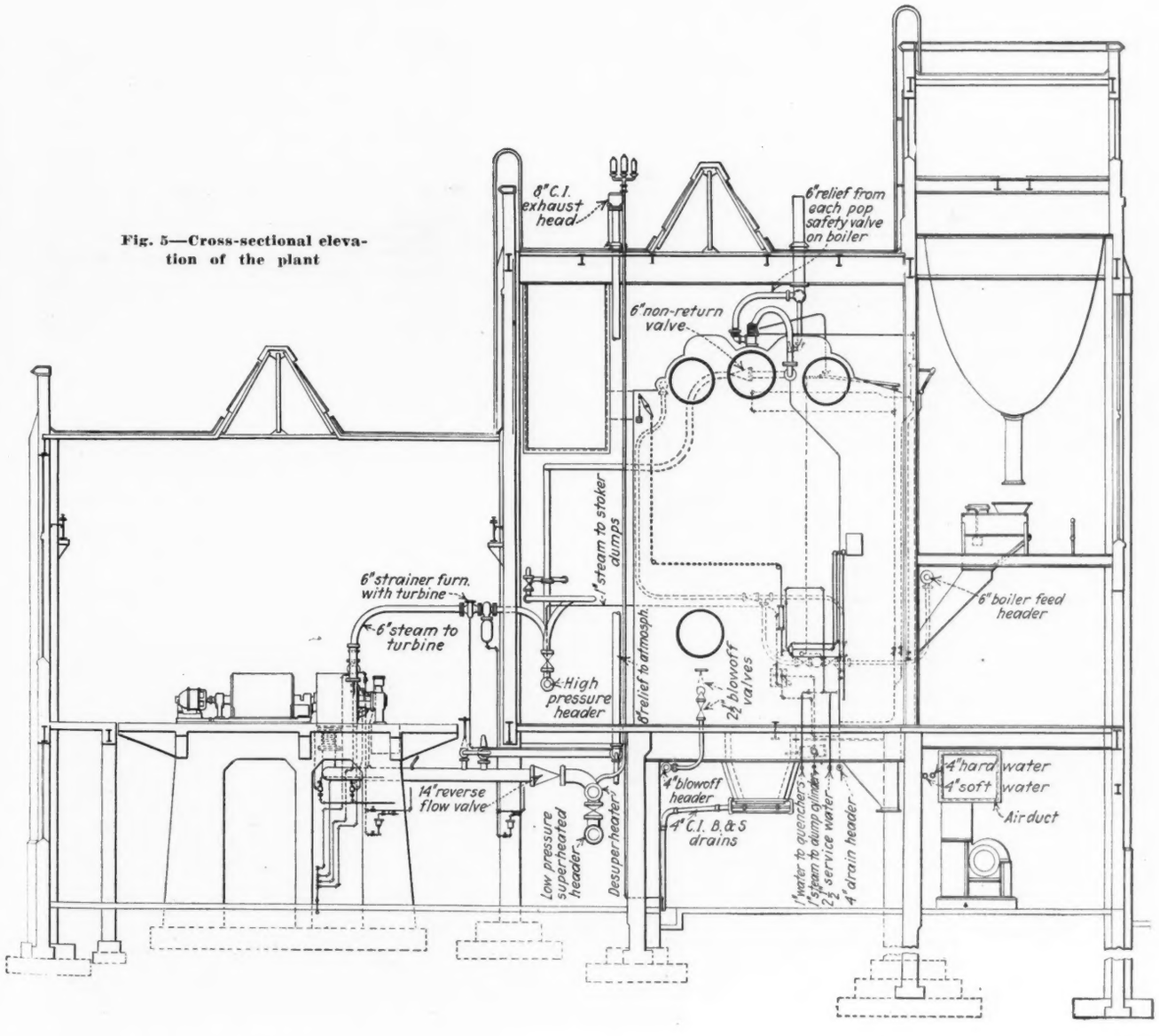


Fig. 5—Cross-sectional elevation of the plant

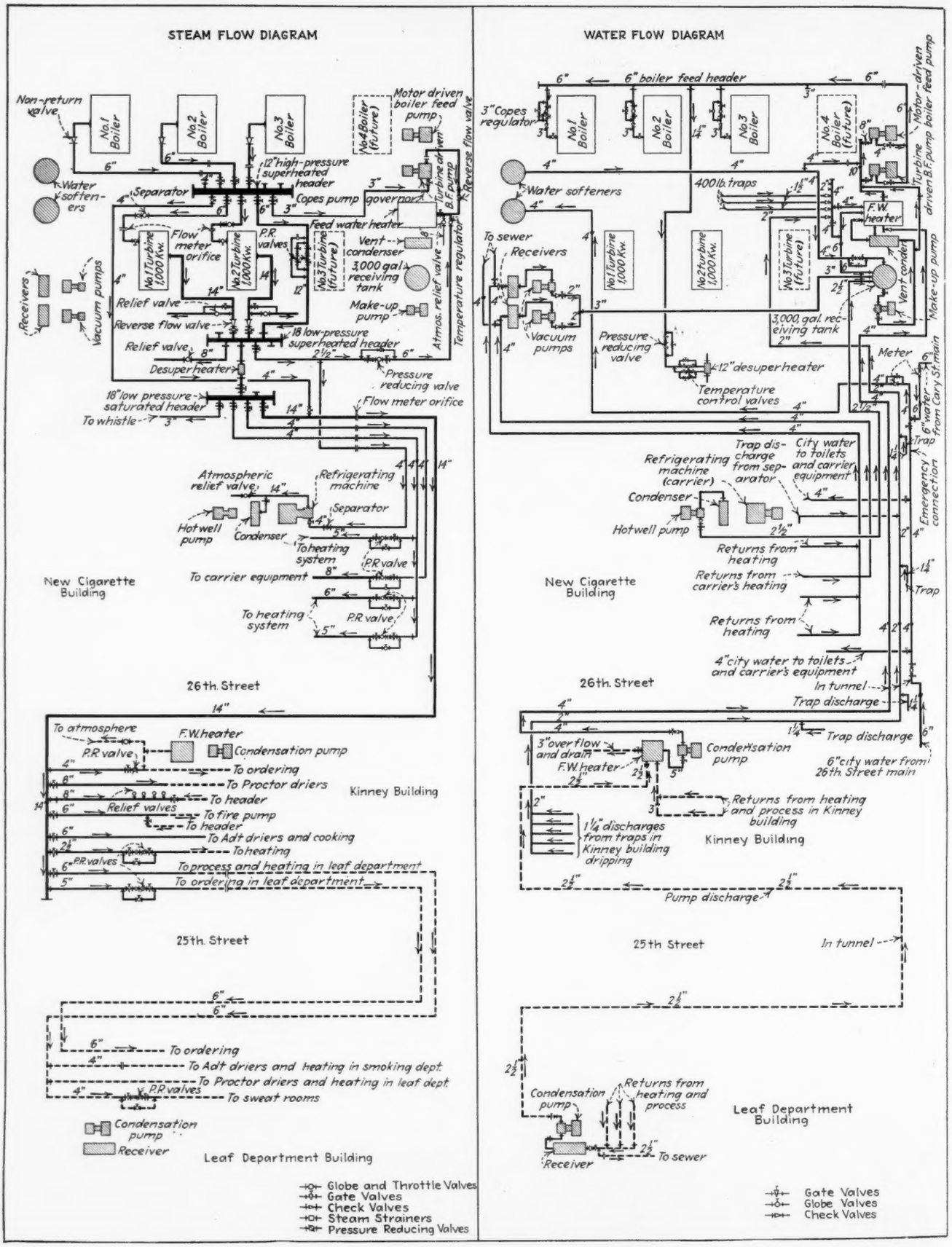


Fig. 6—Steam and water flow diagrams of the plant

Principal Equipment in Lucky Strike Power Plant

Coal and Ash Handling

Track hopper ..... Fairfield Engineering Co.
Belt conveyor, 18-in. rubber ..... Fairfield Engineering Co.
Bucket elevator, shuttle type ..... Fairfield Engineering Co.
Coal storage, 450-ton silo ..... Fairfield Engineering Co.
Coal bunker, 500-ton steel ..... Richmond Structural Steel Co.
Coal weighing, automatic scale at each boiler, Richardson Scale Co.
Ash hopper ..... R. H. Beaumont Co.

Boiler Room Equipment

Boilers, three, four-drum bent tube type, 5,030 sq.ft., 450 lb., Edge Moor Iron Co.
Superheaters to give 150 deg. ..... Foster Wheeler Corp.
Stokers, Taylor straight-line drive, 4-retort; 5 speeds on motor and 2 speeds on stoker ..... American Engineering Co.
Furnace lining (1 ashland crown brick), North American Refractories Co.
Non-return valves ..... Edward Valve & Mfg. Co.
Safety Valves ..... Consolidated Ashcroft Hancock Co.
Draft Fans, two 28,000 c.f.m. G. E. motors ..... Clarage Fan Co.
Draft fan regulators ..... Mason Regulator Co.
Draft cages ..... Bailey Meter Co.
Balance draft equipment ..... The Engineer Co.
Chimney, 225 ft., tile, 10 ft. 2½ in. at top, 17 ft. 6 in. at bottom, Alphons Custodis Chimney Construction Co.
Water column, high pressure type .... Reliance Gauge Column Co.
Feed regulator (Copes) ..... Northern Equipment Co.
Blowoff valves, tandem type ..... Yarnall-Waring Co.
Scot blowers, 6 elements each .... Diamond Power Specialty Corp.
Boiler meters ..... Bailey Meter Co.

Feed System

Heater, 140,000 lb. hourly capacity, deäerating type ... Elliott Co.
Feed temperature control, thermostatic ... ... Fulton Sylphon Co.
Sump float control ..... Fisher Governor Co.
Water treatment ..... Permutit Co.
Feed pumps, two de Laval 4-stage, 223 gom, one d.c. to 123 hp. G.E. motor and one to 125-hp. turbine, De Laval Steam Turbine Co.
Heater pump, one single-stage 235-g.p.m., direct connected to 7½-hp. 1,740-r.p.m., G.E. motor .... De Laval Steam Turbine Co.

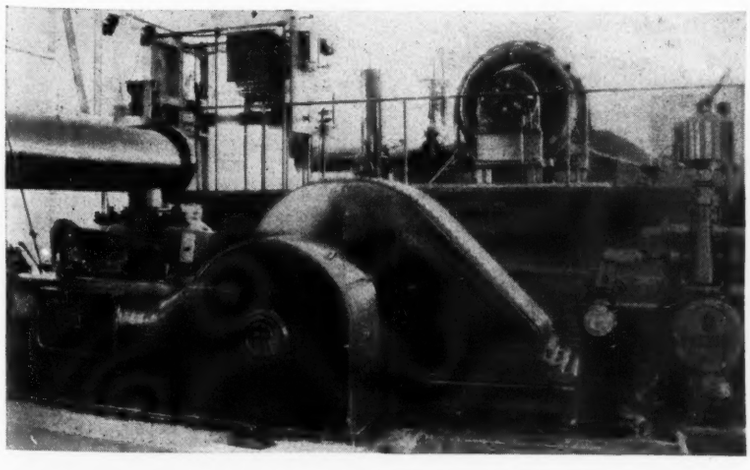
Turbine Room Equipment

Turbines, two 1,000 kw., 3,600 r.p.m., exhausting at 90 lb. gage ..... General Electric Co.
Turbine oil coolers ..... Andale Co.
Turbine expansion joints ..... E. B. Badger & Sons Co.
Steam separators ..... Cochrane Corp.
Traps ..... Armstrong Machine Works
Desuperheater ..... Schutte & Koerting Co.
Pressure reducing regulator ..... Ruggles-Klingemann Mfg. Co.
Gate valves ..... Chapman Valve Mfg. Co.
Globe valve ..... Edward Valve & Mfg. Co.
Piping ..... Grinnell Co.
Relief valves ..... Crosby Steam Gage & Valve Co
Steam meters ..... Bailey Meter Co.
Pipe covering ..... Johns-Manville
Instruments ..... Consolidated Ashcroft Hancock Co.
Returns pump ..... Nash Engineering Co.
Exhaust heads ..... Atwood & Morrill Co.
Relief valve on air condition turbine ..... Cochrane Corp.
Air conditioner ..... The Carrier Corp.
Compressors ..... Ingersoll-Rand Co.
Power house building ..... Wise Granite & Construction Co.

All piping is covered with insulation and canvas jacketing. To indicate the pipe contents the canvass is painted in various color combinations.

The plant is operated with as small an amount of labor as possible. On the day shift the turbine operator works 10½ hr. and the oiler 11 hr. In the boiler room there is a fireman and a helper on each 12-hr. shift. Including the chief engineer, the force is made up of eight men.

J. E. Sirrine & Co., Engineers, Greenville, S. C., designed and supervised construction of this power plant.



The air compressor and the generator are both driven by impulse-type waterwheels

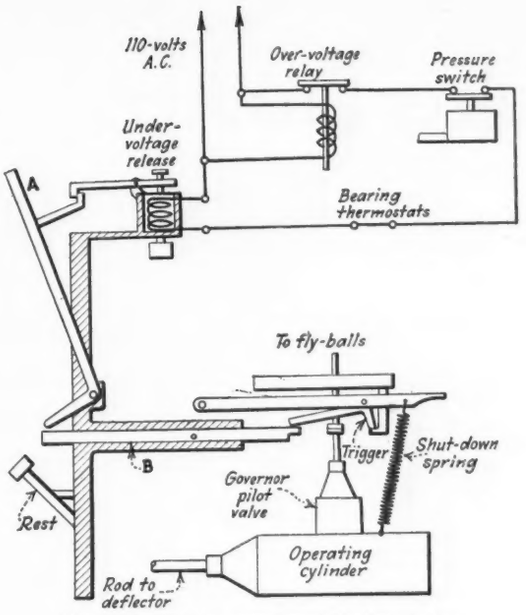


Diagram of the governor tripping device

Home-Made Device Stops Waterwheel Automatically

By J. G. CRAFT

AT THE Coast Copper Company's plant, Jeune Landing, B. C., both the generator and the air compressor are driven by Pelton waterwheels. The generator is rated at 187 kva., 2,300 volts, and the two-stage air compressor 1,000 cu.ft. per minute. The speed of the generator and the compressor is controlled by oil-pressure governors that regulate by deflecting the water from the wheel. The generator has a voltage regulator and is protected against overload, overvoltage, undervoltage, overspeed and low oil pressure on the governor. If any of these troubles develop the generator is automatically shut down.

These faults act on a device that was built to release the governor's safety-spring trigger. The arrangement of the parts is shown in the diagram. Including the overvoltage relay, pressure switch and undervoltage relay, the equipment cost less than $100 to build. The safety spring shuts the plant down if the governor belt breaks. Arm *A* is held in place by the armature of the undervoltage relay as long as the voltage is above a predetermined value. On low voltage the undervoltage relay's core drops and releases arm *A*. As the arm drops its lower end causes *B* to move and releases the governor safety trigger. This operation allows the spring to move the pilot valve to a position to shut down the waterwheel. The contacts on the governor pressure switch and the overvoltage relay are in series with the undervoltage relay coil. Should either of these contacts open, the undervoltage will release its core and shut down the waterwheel driving the generator as previously explained.

Sulzer Brothers Build 10,800-Hp. Diesel

The latest European Diesel builder to construct large two-cycle, double-acting diesels is Sulzer Brothers, Winterthur, Switzerland, who have just completed tests on a 10,800-hp. unit

By OLIVER F. ALLEN
Consulting Engineer
New York City

IT WAS stated in the discussion of the large oil engine for central station service, which appeared in the Oct. 29 number of *Power* that the oil engine is now proving itself in units from 10,000 to 25,000 horsepower.

These land engines are all two-cycle, double-acting. The first single-cylinder large double-acting experimental engines, built between 1924 and 1926, were designed for from 84 to 120 r.p.m. and had cylinders of from 680 mm. (26.75 in.) to 900 mm. (35.5 in.) bore.

In 1926 the first commercial engine in this range, of M.A.N. design, built by Blohm & Voss, a 9-cylinder, 860 mm. (33.87 in.) bore, 15,000 hp. at 94 r.p.m., air-injection machine, was put into service in the Electricity Works at Hamburg, Germany. It has been in regular peak-load and emergency service ever since.

The next two, built by M.A.N. and employing solid injection, had 10 cylinders 600 mm. (23.62 in.) bore each, and were rated at 11,700 hp., at 214 r.p.m. These were placed in the Henningsdorf peak-load station, Berlin, Germany, and underwent official trials in 1928. More complete tests were made in 1929, when the new output per engine, after deducting for the scavenging-air turbine-blower and the circulating-water pump, was 10,720 hp. at 214.2 r.p.m., with a fuel consumption of 0.355 lb. per brake horsepower-hour.

The fourth engine of over 10,000 hp. completed is the Sulzer machine, and while rated at 10,800 hp. at 150 r.p.m. it developed 12,500 hp. during shop tests.

It is expected that the fifth to go into service will be the Burmeister & Wain, 22,000-hp., 8-cylinder, 840 mm. (33.06 in.) bore by 1,500 mm. (59 in.) stroke, solid injection engine for the city of Copenhagen (Denmark) Electricity Works.

Of these five engines, totaling over 70,000 hp., built at four different works, in three European countries, two

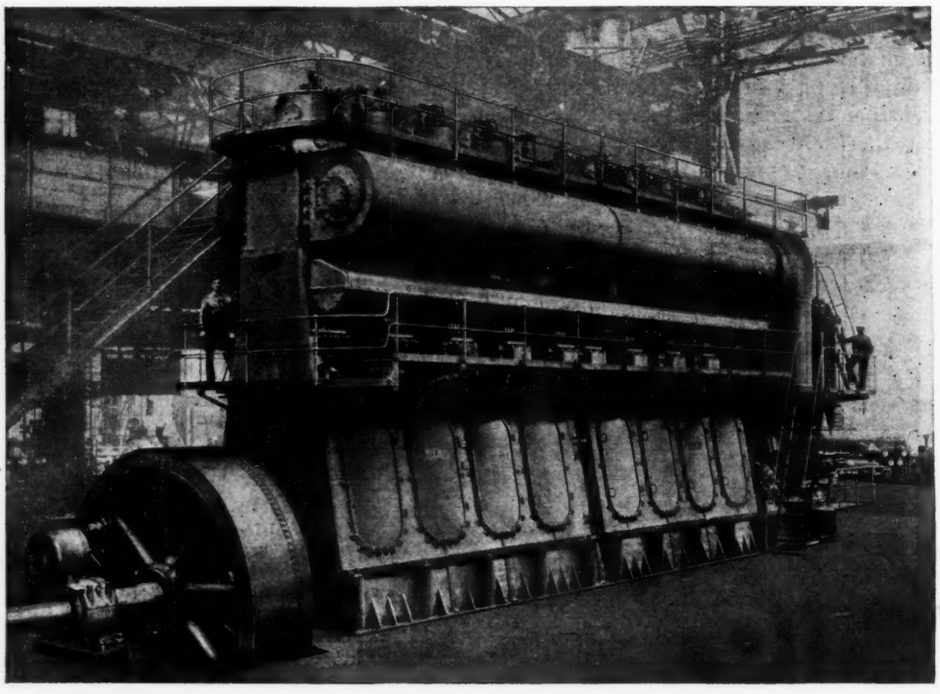


Fig. 1—View of the 10,800-hp. double-acting Sulzer diesel engine on the test bed

are air-injection and three are solid-injection types, but as two of these latter three are duplicates, the four designs are equally divided between air and solid injection. However, as Sulzer is building three more, only a little smaller, to use solid injection, it is evident that that type is gaining for these large engines.

The two M.A.N. designs have turbine-blowers for scavenging air; the Burmeister & Wain, chain-driven positive pressure rotary blowers; and the Sulzer, a direct-connected reciprocating air pump.

The new Sulzer engine, Fig. 1, for La Maigrauge power station of the Entreprises Electriques Fribourgeoises, Fribourg, Switzerland, recently ran its official trials on the test floor at Winterthur. The engine works on the double-acting, two-stroke cycle, with the Sulzer scavenging system and air injection. It develops normally 10,800 hp. in 8 cylinders of 700 mm. (27.56 in.) bore when running at 150 r.p.m. This is the largest as well as the first engine of the double-acting type to be

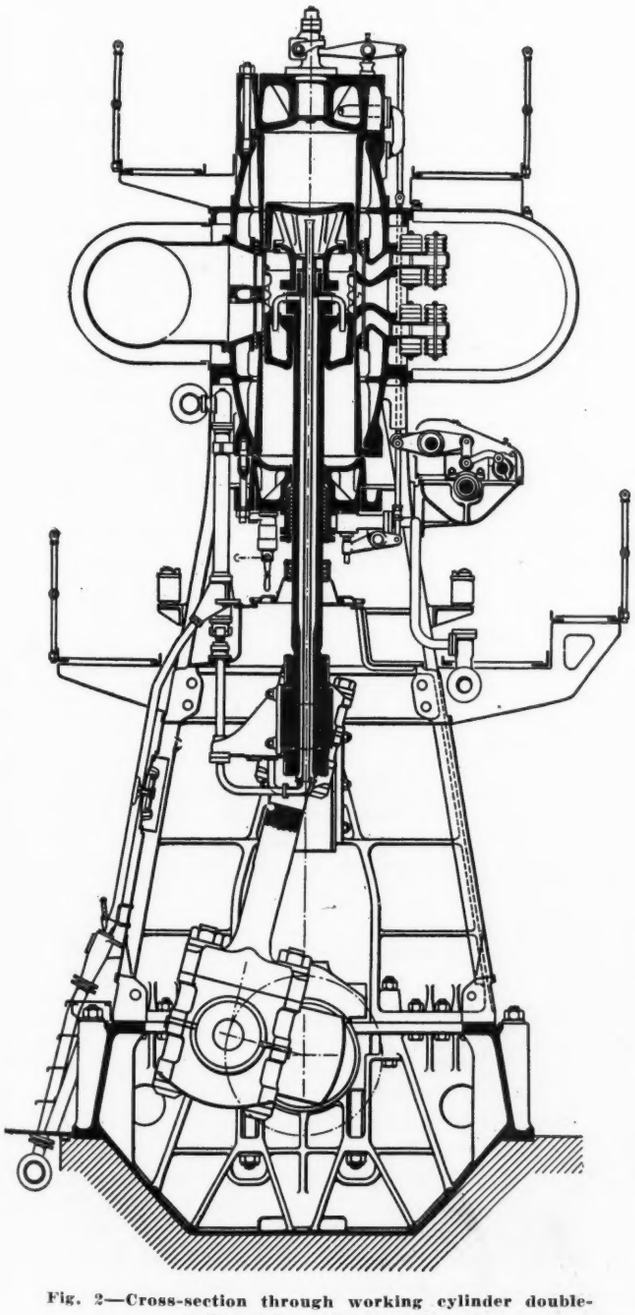


Fig. 2—Cross-section through working cylinder double-acting Sulzer diesel engine

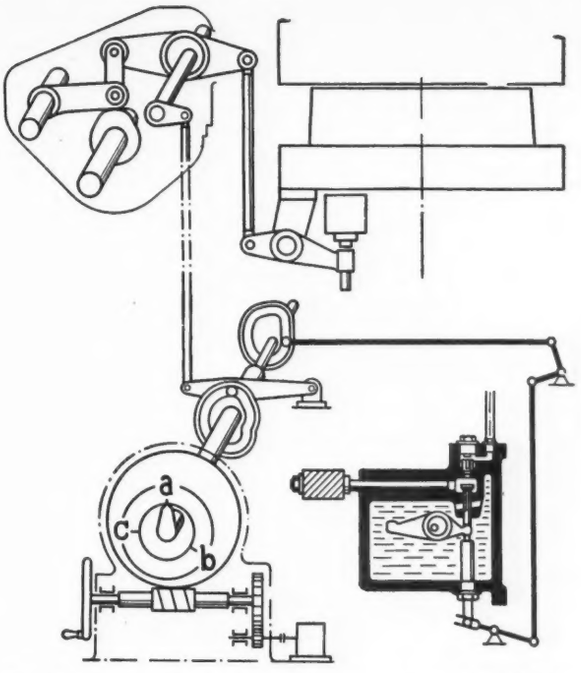


Fig. 3—Arrangement of starting servomotor of the Sulzer diesel engine

installed in Switzerland. Three other engines of the same type, but employing solid injection, totaling 22,000 hp., are under construction for another Swiss electricity works. Each is to be rated at 7,400 hp., the 8 cylinders being 600 mm. (23.62 in.) in bore.

The bedplate of the 10,800-hp. engine, with the columns and the cylinder jackets, forms a rigid bolted frame, which takes up all the forces caused by gas pressure and moving masses. The columns carry the oil-cooled slides for the crossheads. The camshaft for operating the starting and fuel valves is below the scavenging-air piping and is driven by gearing in the middle of the engine. The scavenging-air pump and the compressor for injection and starting air are driven by the engine itself. The fuel pumps, which are arranged at the side of the compressor, are driven from the compressor crosshead.

The design of the engine shows some new features. Each cylinder jacket is cast in a single piece. The middle part is of rectangular cross-section and contains on one side the passages for scavenging and charging air, and on the other side the exhaust passages, which are separated by a cooled partition. The liners, which are inserted into the cylinder jackets from the top and from the bottom, are centered relatively to each other by means of a grooved joint. On the inner side the joint is sinuous and has a certain amount of axial play; it is also slightly bevelled, to allow the piston rings to slide over it without shock. On the scavenging side the liners have three rows of ports arranged above each other. Through the inner, or central row, scavenging air is supplied alternately to both ends of the cylinder; the two outer rows of ports supply scavenging and charging air through automatic valves to each end of the cylinder. On the exhaust side there is a row of exhaust ports for each end of the cylinder. The upper cylinder cover is held down on the liners by bolts and a press ring, the standard Sulzer practice. The central bore in the cylinder head carries the fuel valves. The lower cylinder cover is shell-shaped inside and contains, in addition to the stuffing-box for the piston rod, two fuel valves and one starting and one

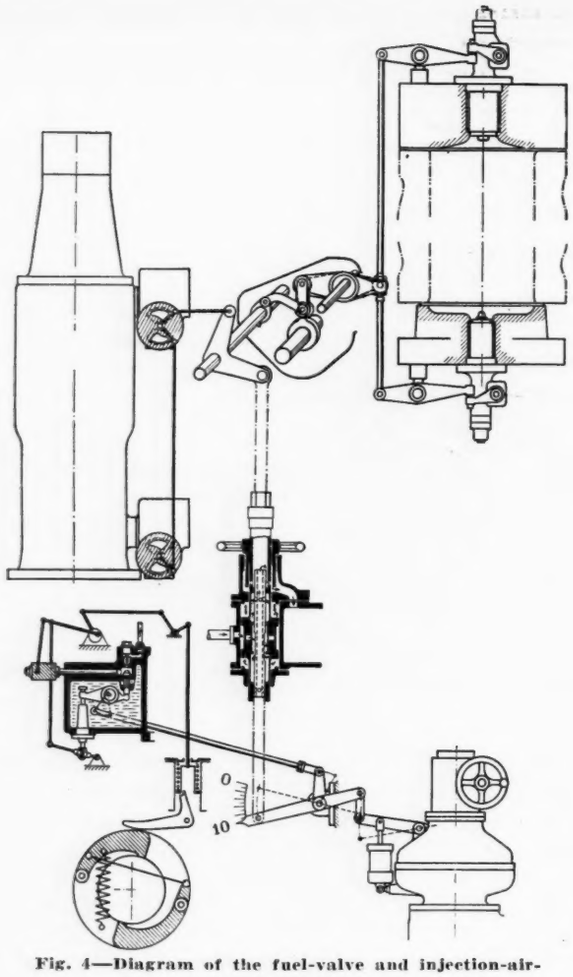


Fig. 4—Diagram of the fuel-valve and injection-air-pressure control

safety valve. The lower cylinder cover is held against the cylinder liners by a press ring in exactly the same manner as the upper cover. The valve gear is arranged in such a way that the fuel valves can be taken out without altering the setting of the gear or dismantling individual parts.

The stuffing box for the piston rod consists of a number of annular chambers, each fitted with two inwardly expanding cast-iron rings. It is easily accessible when the engine is running, and can be drawn downward and inspected without dismantling the cylinder. The piston rod is led through the crosshead and secured to it by two strong nuts, thus facilitating adjustment of the compression.

As is well known, the question of cooling the pistons presents no slight problem in the case of double-acting engines. In the Sulzer engine the cooling water is led to the bottom end of the piston rod, from whence it rises through the hollow rod and reaches the lower half of the piston through two chambered openings; it then rises into the upper cooling space, finally flowing away through a pipe arranged centrally in the bore of the piston rod. For passing the cooling water from the fixed parts to the moving ones, jet and catching nozzles are provided, which have the advantage that no stuffing boxes under pressure need be used. It is impossible for cooling water to find its way into the crankcase, or for oil to find its way into the piston-cooling system. The operation of the jet cooling may be inspected through observation glasses while the engine is running.

The engine is started by compressed air introduced to the lower ends of the working cylinders. At the same time the upper ends are put on fuel, so that ignition begins at once. Starting air is then shut off and fuel is ntroduced to the lower ends of the cylinders. The whole starting operation is effected automatically from a servomotor operated by compressed air. The action of the servomotor, and consequently the starting of the diesel engine, is controlled by a small hand lever. In Fig. 3 is shown the arrangement of the servomotor, which also controls the fuel pump during the starting period, so that fuel is delivered to the ends of cylinders in the order described.

The speed of the engine is regulated by a ball governor arranged at the front end of the engine, immediately beside the fuel pump.

The system of fuel-pump and valve-lift regulation is shown in Fig. 4. The governor controls a servmotor operated by oil under pressure and adjusts the lift of the fuel valve to suit the load on the engine by allowing the fuel roller to remain a longer or a shorter time in contact with the cam, by swinging the link out or in. The servomotor also controls the suction valve of the injection-air compressor, so that the quantity of air required for pulverizing the fuel is adjusted in accordance with the load on the engine. The governor also automatically adjusts the injection-air pressure to suit the load, and this, in conjunction with the valve-lift regulation already mentioned, insures perfect combustion of the fuel.

The engine will work in conjunction with a hydraulic energy storage plant. It will serve principally for supplementing the energy generated by the hydraulic plant in years when there is a shortage of water, when it must run continuously for about 6 to 8 months annually.

In addition, the engine serves as a stand-by, and can be started and brought up to full load in a few minutes.

More and more preference is being shown for the diesel engine in peak-load service, one reason for this being that the diesel engine, in consequence of the cleanliness of its working and the little space it takes up, can be installed without difficulty right in the center of the district supplied with electric energy. In addition to that, it is ready for service at any moment. It helps to relieve the load on the distributing mains, and also increases the value of the power station as a reserve which can be called on at any time.

▼

Supervisory Control Pipe-Line Pumping Station Operation

THE Texas Empire Pipe Line Company has operating on its system several large electrically driven pump stations. At one of the stations, near Tulsa, Okla., it is pioneering in a practical demonstration of equipment and operating methods, involving the use of automatic switching and supervisory control, which promises large savings for the pipe-line industry.

A study has been made to show the economies possible in case such equipment were installed on the basis of a typical 451-mile pipe-line section with nine equally spaced pumping stations. An economic analysis by Westinghouse engineers shows a profit of 23 per cent on the additional investment required, after deducting 18 per cent carrying charge to cover interest, depreciation, taxes and insurance. These savings are made

possible through the use of automatic and supervisory control of pumping stations. By this means a group of pumping stations can be placed under the direct control and supervision of a centrally located dispatcher. The usual three operators for each station are eliminated, together with the considerable expense of providing housing facilities for them.

Seated at a control desk, it is possible for the dispatcher to all times be advised of the operating status of equipment in all stations within 200 miles in either direction. The indications come to him automatically over telephone-type line wires, through the vari-colored glow of tiny lamps dotting the miniature replica of the pipe-line system. Suction and discharge pressure at each station or oil level in the surge tanks can be similarly reported. By means of operating keys associated with the various indicating lamps, the dispatcher can perform any necessary operation in any of the stations under his control, such as opening and closing of valves, starting and stopping of units, etc. The individual stations would operate under the control of local automatic devices which would effect a proper sequence of detail operations after receiving the control impulses from the supervisory control and also protect the equipment and the line against abnormal conditions. The operations would at once be reported back to the dispatcher over the supervisory control.

Although the application to the pipe line industry is new, there is extensive experience with equipment in other fields. Completely automatic, unattended operation of hydro-electric stations and substations has been commonplace for many years in the central-station and electric railway fields, where, as in the case of the oil industry, the requirements for reliability are exacting. Many entire systems are now controlled and operated by one man from a central dispatching point, by means of supervisory control, since the time of the first commercial installation of this kind on the Cleveland Railways, in 1921.

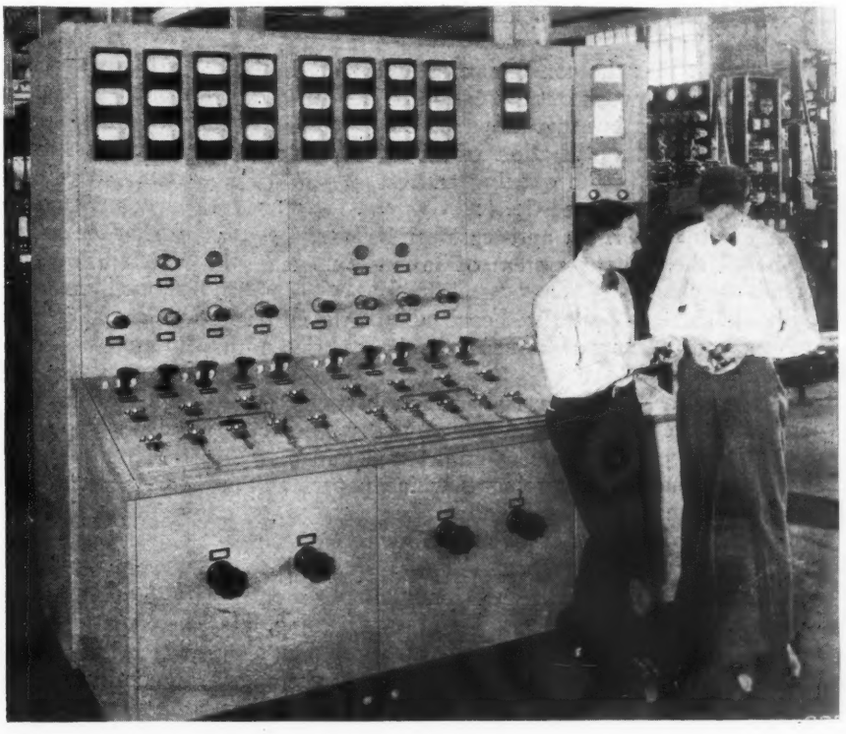
For many years supervisory control which would give continuous, visual indication of the status of the equipment required either three- or four-line wires between the dispatching point and each remote station. With the development of Visicode supervisory control, the same high quality of remote control and supervision became possible with only two line-wires, including provision for operation of a number of stations in parallel on one common two-wire telephone-type line. This latter feature is important in the application to the pipe-line industry, where the distances involved are great and the cost of line wires is a major economic factor.

GREEN SWITCHBOARDS

DESIGN that will blend beauty of detail, congenial colors, graceful lines and balanced proportions into a pleasing and harmonious unity is the art-in-engineering idea of modern industry. As an example of this new trend the Westinghouse Electric & Manufacturing Company has just completed the design and construction of electrical equipment for the ultra-modern control room of the Harding Street power station of the Indianapolis Power & Light Company, Indianapolis, Ind., a subsidiary of the Utilities Power & Light Corporation, Chicago. Every item in the general plan will be related to every other so skillfully that the control room will have the appearance of an attractive lobby.

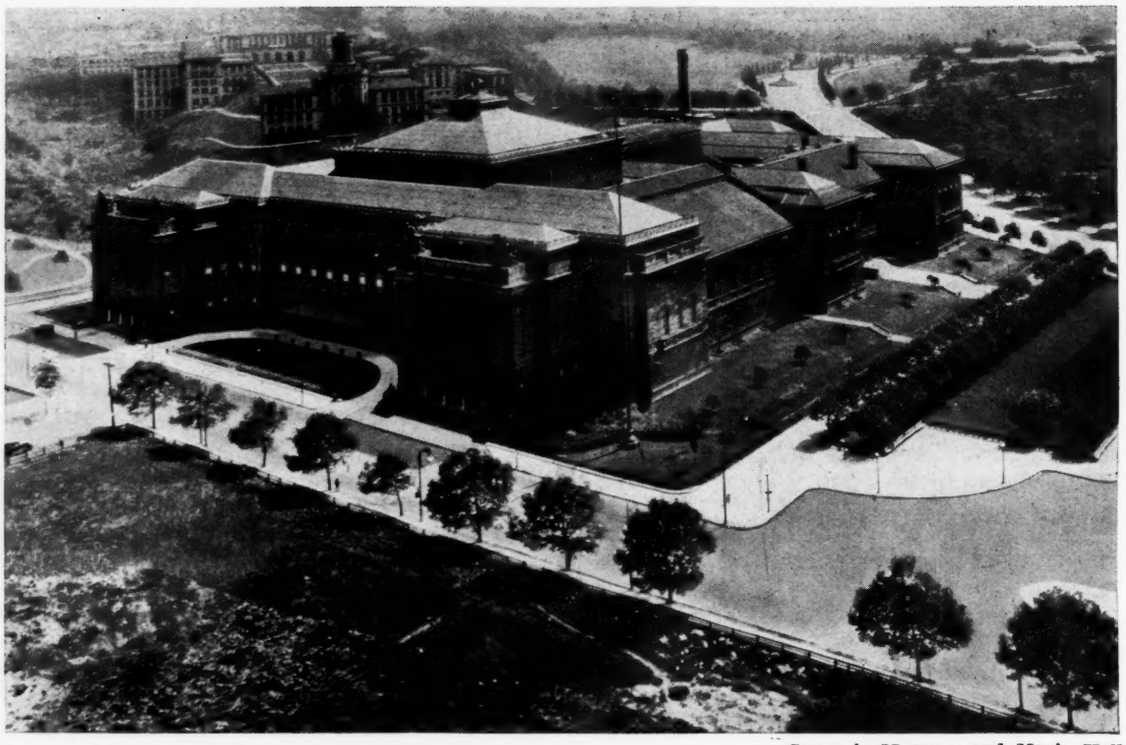
Harmonizing with the walls and other equipment of the control room, the desk is a pastel green in color. The ornamental design of the switches, the bright metal coverplates, the small red, green and white lights, the bars of copper and aluminum metal, the black operating handles and the flush-type illuminated dial instruments effect a pleasing appearance. To conceal necessary but unattractive details the desk is so designed that all of the connecting and mounting bolts are obscured from view by the flanges.

Operation of two 43,750-kva. turbine-generators, each of which has a 2,185-kva. auxiliary generator, will be controlled from the desk. Control of the dual-drive exciter set for emergency excitation for the main units is also located in the same apparatus. The desk will be used in conjunction with two vertical steel switchboards of the swinging-panel type, one for the control and protection of high-tension line circuits, the other for the control of station auxiliary circuits. These boards were also given the same crinkled green finish that will prevail throughout the control room.



Control desk for the Harding Street Power Station of the Indianapolis Power and Light Company

A.J.A. Peterson, left, and G. H. Welch, designing engineers of the Westinghouse Company, are holding the first and the final models of the minature switch used on the desk. More than 20 different designs were used before a satisfying combination of artistic beauty and engineering efficiency was evolved.



Carnegie Museum and Music Hall, where the conference was held

Bituminous Coal Conference Stresses Need for Stability in the Industry

THE Third International Conference on Bituminous Coal opened at the Carnegie Institute of Technology, Pittsburgh, Pa., Monday, Nov. 16, with 1,225 registrants, including scientists and delegates from a score of countries.

Pointing out that the conference affords neither time nor opportunity to work out a solution to the difficulties of the coal industry, but that its purpose is to show mine owners the trend in utilization of their products, Dr. Thomas S. Baker, in the opening address, nevertheless advanced the following questions:

1. Should the Sherman anti-trust act be modified?
2. Should the present system of taxing undeveloped coal lands be changed?
3. Should there be centralized coal sales organizations?
4. How can output of mines best be restricted to needs of consumers?
5. How can a system of cooperation between mine owners of different states be arranged, and what should be the relation between mine operators and miners,

These are some of the problems which papers at the conference attempted to illuminate.

Myron C. Taylor, chairman of the Finance Committee of the United States Steel Corporation, in the first paper presented, characterized proposals for nationalization of coal lands as both un-American and uneconomic, although he conceded that some form of regulation presented possibilities. He did not subscribe to the view that the coal situation is hopeless without new laws, but believes that a constructive cooperative plan, perhaps with government sanction, would bring about the needed results if sincerely undertaken.

He attributed the principal difficulty to a lack of will on the part of the industry, rather than to the existence of anti-trust statutes. The law of supply and demand he regards as supreme, and believes that any additional legislation or artificial measures looking to price control will fall down because they are unsound. The spirit of competition must be retained as the life of the industry.

Governor Albert C. Ritchie, of Maryland, warned the bituminous coal industry of the dangers likely to accompany government ownership or federal regulation. Aside from the probable loss in relative efficiency of industrial operations under govermental regulation, the fact of the probable stifling of free and competitive development of that industry, under such a regulative system, is sufficient to condemn it, in the opinion of Governor Ritchie. He felt that such industries as the power and bituminous coal industries, standing as they do almost on the threshold of their development, should be kept free for the competitive and creative forces, which have carried business forward in its natural path, to continue their normal operation.

Following the general session of Monday morning an

afternoon session took up the subject of "Economics of the Coal Industry." The keynote of this session was that state rather than federal regulation offers the greater possibility for successful solution of the industry's difficulties.

C. E. Bockus, president of the National Coal Association, discussed the decline in coal production in the United States. Judging from figures for the first ten months of 1931, there will be a dropping off in coal production, as compared with 1930, of around 60,000,000 tons, due largely to the present business depression. From a peak of 580,000,000 tons in 1918, it has slumped this year to probably less than 400,000,000 tons. While the general business depression doubtless accounts for a certain part of this loss, economies in utilization and competition from natural gas and oil will also have been important factors.

A greater efficiency has accounted for an annual saving by the railroads of around 28,000,000 tons, and by industrial plants of at least 40,000,000. Coal replaced by other fuels he estimated at 60,000,000 tons. So long as we have oil and gas as competitive fuels, and hydro plants as rivals in power production, there can be no forcing of coal prices to high levels. Sane and economic limitation of coal production, however, might insure prices that would be a decided improvement over the ruinous ones now prevailing.

Dr. L. E. Young, vice-president of the Pittsburgh Coal Company, reviewed a number of proposals for the stabilization of the bituminous coal industry as offered by executives and operating officials of coal mining companies, consumers, labor organizations, consulting engineers, the technical press, trade and business organizations, economists, legislators and government commissions. The diversity of opinion was very marked, and included advocacy of consolidation, production control, price control, sales programs, revision of freight rates, federal fact-finding, federal ownership, and classifying coal mining as a public utility.

The classifying of these proposals did, however, show that public opinion is changing on the subject. The trend of thought appears to be away from nationalization and federal control; away from fixing prices and wages by law; away from federal control generally and toward state control and state compacts; toward conservation of natural resources by state legislation; toward consolidations not planned to create monopoly and to establish uniform prices; toward elimination of unfair competition; and toward the determination of approved prices in advance.

Prof. W. T. Thom, Jr., of Princeton University, discussed the relationship of bituminous coal to oil and gas. With almost unlimited resources of coal, oil and gas, and with the natural-gas industry on the threshold of a marked expansion, we may expect our use of natural gas to increase rapidly for several years, and our consumption of coal and oil to decrease gradually from year to year. The coal industry can be restored to good wages and fair profits if it organizes for cooperative marketing. However, if coal operators cannot or will not cooperate, it may be necessary for the governors of the coal-producing states to do as the governors of Oklahoma and Texas have recently done in curbing the over-production of oil.

Self-regulation of the bituminous industry would solve the coal problem, in the opinion of Professor Thom, but that the industry can regulate itself has not yet been demonstrated. Conditions are admittedly bad, but not hopeless. Courage and honest facing of the facts, group planning, and proration of production can revive the industry.

At the close of the discussion a resolution, passed at the request of Doctor Baker, president of the Carnegie Institute of Technology, and chairman of the Bituminous Coal Conference, provided for the appointment of a committee by the chairman of the conference—"to receive recommendations as to the best means of securing an agency for bringing about the economic coordination of the coal industry."

A committee of five was appointed by Dr. Baker and on Thursday, Nov. 19, the closing day of the conference, reported that after considering the views of leaders of the coal industry and others as outlined in Dr. L. E. Young's paper, as well as the six general plans submitted to the committee, they found such divergence in the views as to make it impossible to coordinate the suggestions into one policy. It was suggested that these plans be laid beforea conference of the governors of the coal-producing states.

Competitive Position of World Coal

The competitive position of world coal was admirably presented in a paper by Alfred G. White of the National Industrial Conference Board. In 1909 coal supplied 89 per cent of the world's demand as a source of heat, light and power. It maintained this position in 1913, but in 1929 the total coal consumption had fallen to ten million tons above that of 1913, although the energy demand had doubled during this period. Against this must, of course, be considered an estimated average increase of 25 per cent in fuel utilization of all kinds. The annual consumption of oil, the principal competitor of coal, has increased to four times that of 1913. Natural gas is a major competitor of coal only in the United States, where 95 per cent of the world's natural gas is used.

In North America in the period from 1913 to 1929 coal declined from 85 per cent of the total energy supply to 64 per cent; oil increased from 7 to 24 per cent; natural gas from 4 to 7 per cent, and water power remained at about 5 per cent. The peak of coal consumption was 624 million tons in 1917.

In Northern Europe coal supplied 95 per cent of the energy and by 1929 this figure had dropped only to 90 per cent with oil supplying 6 per cent and water power 4 per cent. There has been a shifting of supply among various regions, in which England has suffered greatly.

In Northern Asia coal is still dominant, although water power development is a factor. In Africa, Southern Asia and Australia there has been a slight increase in coal consumption since 1913.

In South America oil is the dominant fuel and coal has declined.

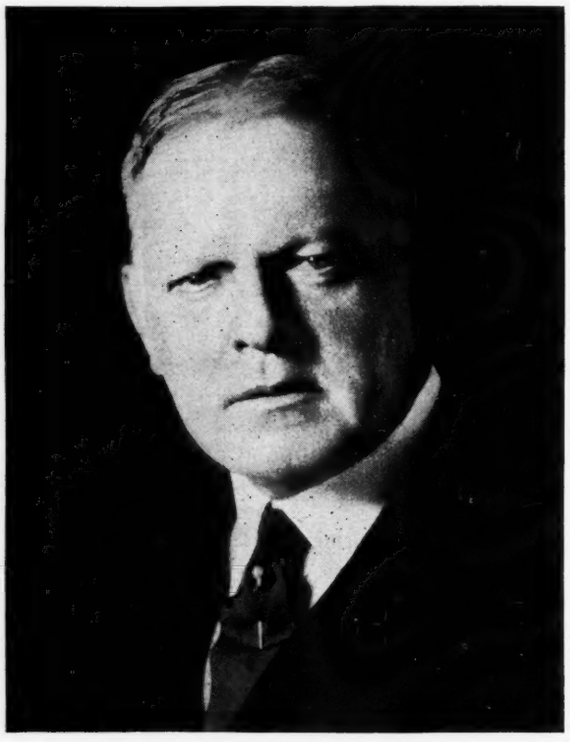
Mr. White, in conclusion, attributed present conditions in the coal industry to the combined effects of increased efficiency in utilization, competition from other sources of energy and the tendency toward a shift in coal production with the rise of new industrial areas.

Competition Between Fuels

The competition of natural gas and fuel oil with bituminous coal is a live actuality. To underestimate this competitive activity is only to evade the facts. However only a limited part of the decreased or declining consumption of bituminous coal can be charged to the

encroachment of natural gas and oil. The major factor in the noticeable recession during recent years has been the increase in the efficiency of coal utilization.

In a paper on "Competition Between Natural Gas and Coal," R. B. Harper, Vice-president Peoples Gas, Light & Coke Company, Chicago, pointed out that while such competition has reached proportions in recent years sufficient to be actively felt by the coal industry it existed back as early as 1880 and has become progressively more active. Transportation facilities for the solid fuels, wood, hard and soft coals were comparatively well organized during the period 1870-1880, while similar facilities for liquid or gaseous fuels were largely lacking. Long-distance high-pressure transmission of gas or oil was unknown. Potential resources of these fuels were largely undiscovered and almost wholly undeveloped. Thus the solid fuels possessed the advantage of being available for supply to existing markets.



DR. THOMAS S. BAKER

President, Carnegie Institute of Technology; Chairman, Bituminous Coal Conference

The ensuing 60 years, however, have witnessed the disappearance of this advantage, and the result is clearly seen in the progressive increase in competitive activity. Graphically illustrating the percentage of total energy utilized that was supplied by the various sources for five-year intervals from 1880 to 1930, Mr. Harper showed that in 1880 anthracite represented about 22.3 per cent, bituminous coal 29.9 per cent, petroleum 3.4 per cent, wood 36.4 per cent, natural gas less than 0.1 per cent and water power 2.1 per cent. In 1930 these figures had changed to: anthracite 7.4 per cent, bituminous coal 46.9 per cent, petroleum 22.3 per cent, natural gas 8.2 per cent, water power 8.4 per cent and wood 5.9 per cent. While the increase in percentage of petroleum and natural gas was continuously greater, these fuels received their greatest impetus following 1920.

Such comparisons of the percentage source of total energy supply hardly offer the true picture of competition of oil and natural gas with coal. A study of the consumption of bituminous coal by various types of industrial usage indicates that about 25 per cent of such coal finds a market in the transportation field (railroads and steamships) where natural gas cannot be considered competitive. Coke ovens take another 15 per cent, gas manufacture 2 per cent.

A similar study of petroleum usage shows 38 per cent for the production of gasoline, while 41 per cent supplies the fuel usage of industry and utility power. The various uses of natural gas show 13.6 per cent utilized in the manufacture of carbon black, which could hardly be considered as in competition with coal, while the 37 per cent used for drilling, pumping and operation of gasoline recovery plants would not be directly competitive.

Thus the total available quantity of the three fuels mentioned cannot be considered as being in direct or even indirect competition. Assuming that bituminous coal would have maintained its upward trend in percentage of the entire energy supply of the United States from 1915 to 1930 (if competition with other energy sources had not existed due to rapid expansion in use), the 445,000,000 short tons of bituminous coal actually used in 1930 would have been 680,000,000 tons instead. The estimated replacement of the extra coal tonnage by the various other energy sources would have been as shown in the table at the bottom of the next page.

In an interesting paper on "Natural Gas and Bituminous Coal," Geo. I. Rhodes, vice-president, Ford, Bacon & Davis, New York, presented the same subject from a somewhat different viewpoint. Evaluating natural gas, fuel oil and water power in terms of coal, he showed that the replacement of bituminous coal consumption by increased use of natural gas was small in comparison to that resulting from increased efficiency of coal use and from increased usage of fuel oil and water power. Fig. 1 shows this in chart form.

The costs of production and transportation of natural gas are often misundersood, and published data frequently misinterpreted. Government statistics indicate that the average value of natural gas at the wells is about 9c. per 1,000 cu.ft. Prices in individual fields vary from 3 to 25c. per 1,000 cubic feet.

Gas from the higest-cost fields is generally used only in the vicinity of the field. Gas from fields of average cost is transported for distances up to about 200 miles. It is only gas from the low-cost fields that is generally transported for long distances and it is only such fields that need be considered as serious future competitors of the bituminous coal industry. With possible future gas transportation costs there is no economic limit to pipe line length if coal and gas are the same distance from the market. Further, natural gas in the future may be transported economically in competition with coal from sources 400 to 500 miles farther away from the market than the coal mines.

Natural gas, however, has been but an incidental factor in restricting growth of bituminous coal and will probably so continue. Increase in railroad freight rates on coal will increase the competition from gas. Where the coal industry is suffering from such competition it should appreciate that the gas will first replace the more inefficient uses of coal and the coal industry can best protect itself by working actively for the more efficient use of its product.

The subject of economics is still in the controversial stage, and perhaps no other division of this department of science has been troubled by so many popular misconceptions and fallacies as has been the case with

the power industry and especially with water power. Elaborating this general statement in a paper on "The Economics of Water Power Vs. Steam Power," which was given considerable discussion, George A. Orrok, consulting engineer, New York, showed that water power was far from being the "free gift of God" of the political spellbinders. Nature supplies the falling water, but someone has to pay anywhere from $100 to $500 per kilowatt of capacity installed for harnessing it.

Transporting Pulverized Coal

What Germany is doing in the transportation of pulverized coal in pipe lines and cars was described by Friedrich Schulte, director of the Association of the Power Industry of the Ruhr District. There such pipe line transporation is done exclusively by pneumatic methods. Suction operation is employed for distances up to 450 yd. and pressure operation up to 2,000 yd. For greater distances intermediate stations are employed and in some cases both pressure and suction are used. The air required is between 4,200 and 10,000 cu.ft. per ton of coal, or 1.5 to 6 per cent of the air for combustion.

A paper by E. G. Bailey and R. M. Hardgrove discussed the "Slag-Tap Furnace and Its Effect upon the Selection of Coal for Burning in Pulverized Form." The authors included a table giving details of sixty-seven such installations comprising a total boiler capacity of 22,592,000 lb. of steam per hour and contended that this type of furnace is applicable to all coals having an ash-fusing temperature below 2,500 deg. F. With coals having higher ash-fusing temperatures it is possible to use fluxes such as mill scale, or soda ash, to make the ash fluid. It was pointed out that the slag-tap furnace permits a reduction in the height of furnace and a corresponding saving in building cost. Furthermore, compared with the furnace designed for dry ash removal it recovers a much larger percentage of the ash in the coal (from 30 to 43 per cent) and thus reduces the amount going up the stack. Also the carbon loss in the slag is practically negligible, a number of cases being cited in which this is less than 0.2 of 1 per cent.

E. H. Tenney, chief engineer, Union Electric Light & Power Company, St. Louis, reviewed some of the theoretical and laboratory investigations of pulverized-coal-burning and attempted to coordinate these with the results attained in actual practice in firing low-grade bituminous coal. For this purpose he presented the results of studies on the operation of two types of firing on high-capacity boilers in the same plant—one vertical streamline firing and the other horizontal turbulent firing. Both types of furnaces were fired with medium-grade Midwest bituminous coal having a heat value of 10,650 B.t.u. and 13 per cent ash with a fusing temperature of 1,980 deg. F.

Studies were made at four or five boiler ratings and

ESTIMATED REPLACEMENT OF BITUMINOUS COAL

Item	Consumption in Equivalent Short Tons		Per Cent of Replacement Energy Supply	Per Cent of Total
Bituminous coal (estimated actual consumption 1930)	.....	445,000,000	....	65.6
Replacement natural gas (estimated actual consumption 1930)	37,000,000	.....	15.7	5.4
Replacement fuel and gas oils (estimated actual consumption 1930)	82,000,000	.....	34.9	12.0
Replacement water power (estimated actual consumption 1930)	82,000,000	.....	34.9	12.0
Replacement miscellaneous energy (estimated actual consumption 1930)	34,000,000	.....	14.5	5.0
Total replacement energy	.....	235,000,000	100.0	34.4
Bituminous coal (estimated 1930 consumption on basis 1900-1915 consumption trend)	.....	680,000,000	.....	100.0

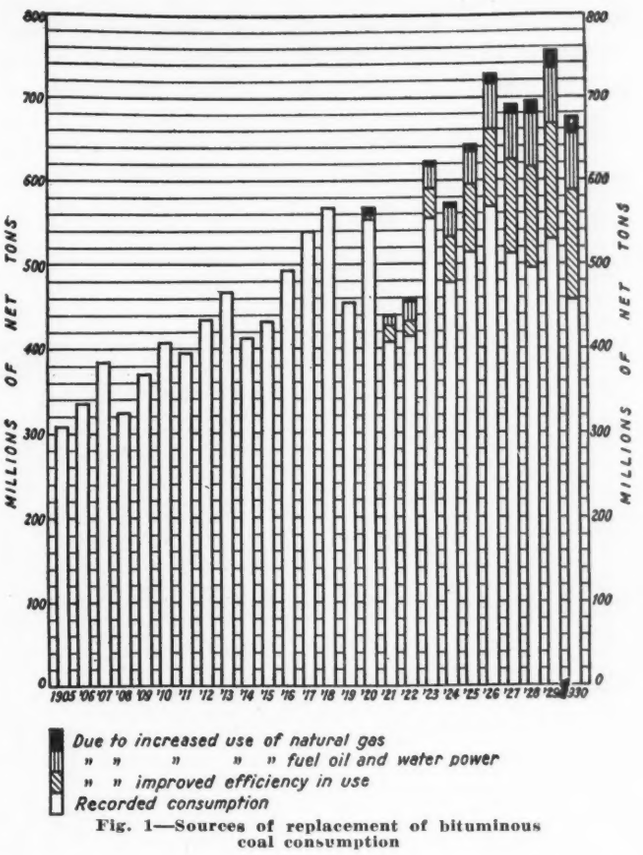

MILLIONS OF NET TONS
MILLIONS OF NET TONS
0
100
200
300
400
500
600
700
800
1905 '06 '07 '08 '09 '10 '11 '12 '13 '14 '15 '16 '17 '18 '19 '20 '21 '22 '23 '24 '25 '26 '27 '28 '29 '30
Due to increased use of natural gas
" " " " " fuel oil and water power
" " improved efficiency in use
Recorded consumption

Fig. 1—Sources of replacement of bituminous coal consumption

indicated a wide difference in the rapidity of combustion with the two methods of firing. With streamline firing at 250 per cent rating (15,100 B.t.u. heat liberation) combustion was complete 36 ft. from the burner tip and 13 ft. from the point of ignition. Final ignition in the core of the flame required 0.7 sec. From burner tip to complete combustion required 1.4 sec. With turbulent firing at the same rating combustion was complete 14 ft. from the burner tip and 10 ft. from the point of ignition. Combustion and ignition required 0.55 sec. Furthermore, with the streamline firing a heat liberation of 15,100 B.t.u. per cubic foot of furnace was about the maximum for this particular installation.

One of the conclusions drawn from these studies was that turbulent firing permits operating with less excess air than is necessary with streamline firing, results in a clearer flame and reduces the tendency to slagging in the pit.

The papers at the first pulverized-coal session were discussed by A. D. Bailey and T. E. Purcell. The former drew attention to the difference between fuel conditions in this country and Europe, and remarked that we are more concerned with economics than the technical ability of inventors. Mr. Purcell observed that operating men are often too prone to leave the solution of their problems to the laboratory or to the manufacturer, and he complimented Mr. Tenney on the studies made at St. Louis. But he called attention to the fact that these furnaces were several years old, hence one should not draw too broad conclusions from their performance. He believed 250 per cent rating a little too high for stream line firing and expressed the opinion that turbulent firing does not permit as great flexibility over wide load changes.

That advances to date in the design of pulverizing mills, burners and furnaces have been largely the result

of trial-and-error development, but that many fundamental studies are now being made as to the process of combustion within the furnace, was apparent from several papers and discussion at the pulverized-fuel sessions. In other words, practice has advanced faster than theory, but has now reached the point where it must await the results of research to clear up uncertain phenomena. Four papers at the Tuesday afternoon session dealt with this phase of the subject. They were "A Study of the Mechanism of the Combustion of Pulverized Coal," by André Grebel; "Effect of Ash on the Reactivity and Combustibility of Carbon Materials," by Y. Oshima and Y. Fukuda; "Mechanism of Combustion of Solid Fuel," by Dr. S. P. Burke and Dr. T. E. W. Schumann, and "Experimental Study of the Process of Combustion of Pulverized Coal," by R. A. Sherman.

After reviewing the work of contemporary investigations, Mr. Sherman reported on the progress of an investigation now being conducted under his direction at Battelle Memorial Institute. This work is being carried on with large-scale laboratory apparatus, large enough to simulate temperature and flow conditions in a commercial installation. Data were presented on combustion tests with three types of fuel, semi-bituminous, bituminous and semi-coke.

Results to date indicate briefly, (1) that with ratios of air to coal equal to or greater than ordinarily required, CO appears only in small amounts, although CO once formed may persist for a considerable distance of flame travel because of slow mixing with secondary air; (2) pulverized-fuel-equipment manufacturers would do well to develop equipment that will deliver a uniformly sized product rather than one of extreme fineness, as the specific surface does not appear to have greater general significance than the percentage passing 200 mesh; (3) rates of combustion and percentages of unburned carbon vary greatly with the type of fuel; (4) semi-cokes having volatile content as low as 12.8 per cent burned satisfactorily in pulverized form; (5) evidence that turbulence is not necessary to obtain high rates of combustion, because the attainable relative velocities between fuel and air are too low to decrease the film thickness appreciably.

The Coal Dust Engine

Progress with the Rupa motor (coal dust engine[1]) was reported in a paper by Rudolf Pawlikowski, which in the author's absence was presented by Prof. Willibald Trinks. This is the seventh engine of this type to be constructed. It has run nearly 1,000 hr. in continuous operation with an average load of about 130 hp. in addition to numerous test runs of 10 to 14 hr. daily. The lubricating oil consumption was found to be approximately 4 grams per brake horsepower-hour if the waste oil is not re-used after filtering. Its thermal efficiency is about the same as the diesel and it consumes practically the same weight of fuel per indicated horsepower-hour for all loads.

Further development in the type of snap rings and better forced cylinder lubrication appears necessary and a new design of cylinder liner, of hardened steel is being tried out.

In a paper describing the operation of large stoker-fired furnaces under suction rather than with balanced draft, Bert Houghton, operating superintendent, Brooklyn Edison Company, also introduced some interesting data concerning the operation of stokers in general.

[1]Described in detail in *Power* March, 1931.

Fig. 2 (from Mr. Houghton's paper) shows the progress of combustion particularly with reference to rate of release of volatile matter. It is interesting to note that the analyses of the fuel are reasonably uniform down the stoker, and only at the overfeed section and the tail of the fire does the burning-out process take place.

Stress was placed by Mr. Houghton on the importance of careful training of the stoker operator and the necessity of insuring that both boiler meters and combustion control apparatus be synchronized by careful calibration throughout their entire range. The skill of the operator and the accuracy of his control instruments are the most important factors in the economical operation of underfeed stokers.

The large attendance and active discussion at the session devoted to small industrial and domestic stokers indicates the coal industry to be acutely aware of the inroads fuel oil and natural gas have made in these heating fields.

While there are some 57 manufacturers of small industrial stokers now in the market, certain of the better known makes are generally reliable and satisfactory for operation under small industrial boilers, according to a series of tests on five well-known makes

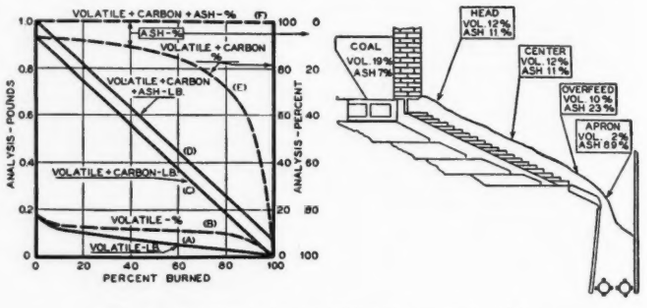

VOLATILE + CARBON + ASH - %
ASH - %
VOLATILE + CARBON - %
VOLATILE + CARBON + ASH - LB.
VOLATILE + CARBON - LB.
VOLATILE - %
VOLATILE - LB.
ANALYSIS - POUNDS
ANALYSIS - PERCENT
PERCENT BURNED
COAL VOL. 19% ASH 7%
HEAD VOL. 12% ASH 11%
CENTER VOL. 12% ASH 11%
OVERFEED VOL. 10% ASH 23%
APRON VOL. 7% ASH 69%

Fig. 2—Progress of combustion on the stoker

by Profs. G. A. Young and W. T. Miller of Purdue University. On 12-hr. reliability test runs, operating automatically, these stokers showed average efficiencies of 68 to 71 per cent at about 100 per cent of boiler rating. On maximum test runs, operating partly automatic but with as much manual adjustment of the fire as was necessary, these stokers operated saitsfactorily up to 220 per cent of rating with heat releases varying from 32,000 to 43,000 B.t.u. per cu.ft. of furnace volume per hour and for varying time periods.

Professor Young stated that the most common error made in the purchase and installation of small industrial stokers was in the choice of the wrong size for the coal to be used. To operate such installations satisfactorily, they were frequently shifted to the best, and consequently highest-priced, grades of special stoker coal, thereby nullifying the stokers' most effective claim—the use of the cheaper grades of bituminous coal.

In a paper on "Domestic Stokers" Walter Barnum, president, the Pacific Coast Company, pointed out that the fuel oil and gas industries have aroused a conscious desire for clean, attention-free heat and have attempted to meet this desire for heating service. The coal industry, on the other hand, has been laggard in recognizing this public demand, but is now in a position to supply it at a cost less than is possible with either oil or gas.

Neither oil, gas nor coal, however, is bought for its own sake. The desire is for clean, safe, attention-free and automatic heat and the value of all the fuels and

mechanical devices on the market is governed by their ability to satisfy this desire.

While domestic stokers have been available for some little time, it is only recently that completely automatic machines, handling several kinds of bituminous coal, including slack and coking coals, have appeared on the market. These stokers, according to Mr. Barnum, fire the fuel automatically, burn it smokelessly at efficiencies of 70 to 75 per cent (tests in homes showing 14 to 16 per cent CO_2 continuously for days at a time), and discharge the ash automatically into standard ash cans for removal. They are controlled automatically by the same type controls as used for oil burners, and give better heat regulation.

Interest Shown in Smoke and Dust Abatement

Smoke and dust abatement was very properly accorded a place on the program. In relating what is being done in England, Prof. C. H. Desch told of the distinction there being made between preventable and unpreventable smoke. Steam boiler and heating furnaces, as well as certain industrial operations, fall within the former class, to which stringent measures are being applied. Other industrial processes, including metallurgical furnaces and bessemer converters, fall within the second class. These, however, are exempt only for a certain period during which it is hoped research will find a solution. Wider application of the electric furnace may prove a factor in this work.

Dr. H. E. Johnstone reviewed the research work that is now being carried on at the University of Illinois Experimental Station, on the elimination of sulphur compounds from boiler furnaces. Coincident research is being conducted at the same university by Dr. R. W. Snow on the cleaning of coal, which indicates that the limit of sulphur reduction commercially by cleaning is in most cases less than 50 per cent, in some cases not more than 25 per cent, although as high as 80 per cent has been removed in the laboratory from a 5 per cent sulphur coal.

According to Dr. Johnstone, from 70 to 95 per cent of the sulphur in the coal burned goes into the flue gas, making a sulphur concentration of 0.3 to 0.4 per cent by volume. Any method adopted for its removal must not materially increase the draft loss and must be accomplished in the shortest possible time at minimum expense. The system of washing employed at the Battersea station of the London Power Company, although dealing with coal much lower in sulphur than our Midwestern coals, requires from 6,500 to 12,000 gal. of water per ton of coal for 67 per cent removal and from 8.5 to 13 sec. The cost of washing is 36c. per ton of coal.

The investigations at the University of Illinois have been based upon the use of catalyst in conjunction with washing. Results to date have indicated that by employing manganese as a catalyst the volume of water required is approximately 270 gal. ($1\frac{1}{4}$ tons) per ton of coal and the time of contact 1/20 sec. Iron as a catalyst is also being investigated.

Complete elimination of smoke was advocated by Hector J. Azbe, consulting engineer, of St. Louis. In the author's opinion, prevailing smoke ordinances will never produce a clean city, because they generally permit continuous smoke of less than No. 3 density and denser smoke for brief periods. More stringent laws are necessary, rigidly enforced, and backed up by a citizen's smoke abatement league in every city. Domestic furnaces in many localities, in the aggregate, are admittedly the greatest offenders and the hardest to control, but Mr. Azbe believed that an effective remedy lay in the employment of a down-draft baffle so that the sequence of combustion and flame travel would always be from fresh to burning coal and never the reverse.

Ely C. Hutchinson, while commending Mr. Azbe's ambition to secure total elimination of smoke, pointed out some of the obstacles to full attainment of this objective. He suggested that much could be accomplished in the handling of the domestic heating situation by instruction in the schools, and further told of the aims and objectives of the Pure Air Committee of the A.S.M.E.

A. D. Bailey of the Commonwealth Edison Company, Chicago, heartily endorsed the aims of the Pure Air Committee to approach the problem constructively and bring together the various interests concerned. In his opinion, the real solution to the problem, especially as concerns the domestic consumer, rests in the supply of the proper fuel. Commenting on the high cost of removing sulphur from the stack gases at the British plant, he believed this cost might better be applied in treating the coal at the mines.

In discussing Mr. Azbe's paper, George A. Orrok took the position that there is no reason to expect any larger reduction in dust and smoke, as the public, to date, has not shown any willingness to pay the cost. Dust, in his opinion, is more serious than smoke, and in certain localities sulphur fumes are factors.

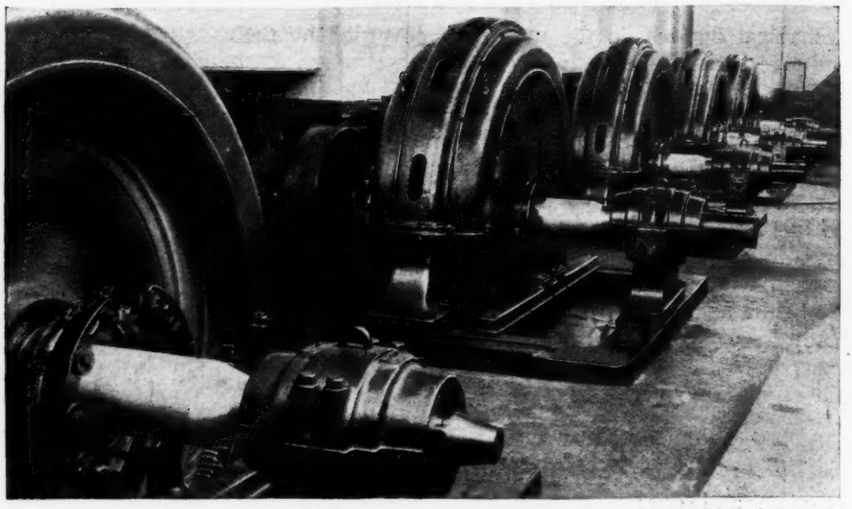
Steamship Fuel

At the discussion on steamship fuel, C. J. Jefferson asserted that the coal industry as a whole has shown indifference to the shrinkage of the bituminous marine market and to the possibilities of more economical use of coal for ship propulsion. In contrast to this indifference he cited the activity of the Petroleum Institute both in research and propaganda and the efforts of the diesel engine manufacturers a few years ago which resulted in the appropriation by Congress of 25 million dollars for the dieselization program of the Shipping Board. With one exception, development of pulverized-coal firing in marine work had been initiated and carried out by ship owners, pulverizer manufacturers and the Shipping Board.

Mr. Jefferson's contentions were seconded by P. C. Pope, secretary of the British Institute of Fuels, who stated there had been similar action on the part of British coal producers in the face of most active competition from oil. Mr. Pope mentioned, incidently, that investigations are now being carried on in England concerning collodial fuel, that is, a 50-50 mixture of pulverized coal and oil. It will be recalled that some work of this nature was carried on in the United States during the war.

Carbonization of Bituminous Coal

Carbonization, both at high and at low temperatures, as well as the extraction and recovery of byproducts, were subjects of major interest at the conference, 39 papers being read dealing with them. The opinions of British and Continental scientists regarding the future of carbonization at low temperatures was decidedly more optimistic than those of the Americans present, as might be expected.



These five 1,000-hp. synchronous motors drive wood-grinder lines

By A. T. HURTER
Resident Engineer
Iroquois Falls Division
Abitibi Power and Paper Co., Ltd.

Motors and Waterwheels Drive Pulp-Mill Grinders

Two waterwheel-driven alternators converted into combination synchronous-motor and hydraulic-turbine drives for pulp-mill grinder lines provide means of obtaining a load balance between river flow and electric power supply from other hydro plants. Ground-wood storage allows using excess water over week-ends and helps to regulate river flow

IN THE Abitibi Power & Paper Company's 600-ton pulp and paper mill at Iroquois Falls, Ont., twelve lines of grinders are driven by 2,000-hp. watewheels, five lines are driven by 1,800-hp. synchronous motors and two lines are driven by either a 2,000-hp. waterwheel or an 1,800-hp. synchronous motor, or by both.

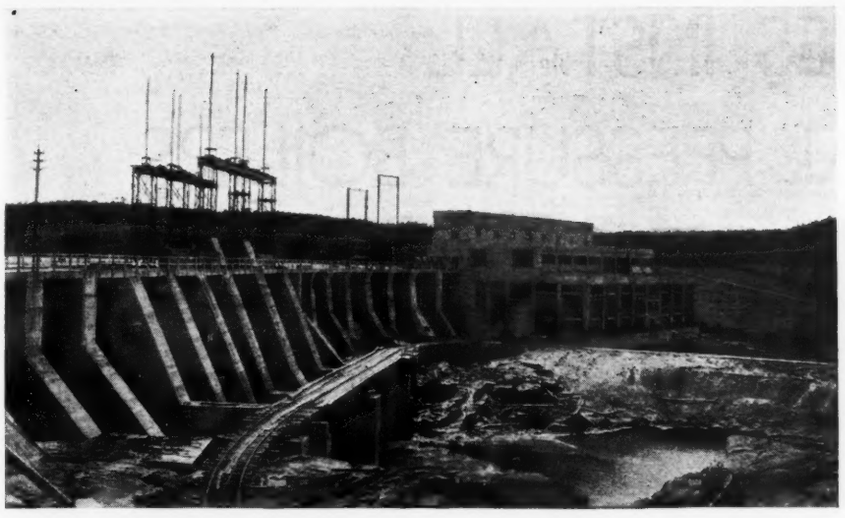
When the mill was first put into operation in 1914 there were ten waterwheel-driven grinding lines and four alternating-current generators, each driven by a 2,000-hp. waterwheel. At that time the mill's capacity was 250 tons of newsprint per day and all electric power was generated locally by the four 2,000-hp. units in the grinder room.

Since then the mill's capacity has been increased to 600 tons per day and all electric power is now generated at two hydro-electric stations. One of these is at Twin Falls on the Abitibi River and has installed five 6,000-hp., 60-cycle units operating under a head of 55 ft. This plant is about ten miles by river above Iroquois Falls and controls the flow from Abitibi Lake. The other plant is at Island Falls about 85 miles below Iroquois Falls and has installed two 12,000-kva., 60-cycle and two 12,000-kva., 25-cycle units. (See Figs. 1 and 2 in the article "Large Paper Mill Reduces Steam Consumption 30 per cent per Unit Production," Nov. 3 number.)

To provide increased grinder capacity required for the paper mill two of the generators in the grinder room were replaced by grinder lines in 1921. The rotors of the two generators were returned to the manufacturers and had squirrel-cage windings put in their poleface to convert the generators into synchronous motors suitable for driving grinder lines. Three new motors were purchased and five motor-driven grinder lines were installed in an extension to the building for the waterwheel-driven grinders. This made a total of seventeen grinder lines, twelve of which are waterwheel-driven.

In 1929 more grinder capacity was required and the two remaining alternating-current generators in the grinding room were replaced by grinder lines. To provide a flexible means of controlling the load between motor-driven and waterwheel-driven grinders and at the same time if necessary have all the grinders in operation, it was decided to convert the two alternating-current generators into synchronous motors and connect them to the two new grinding lines. This allows operating these lines either by waterwheel or by electric motor or both, depending upon the avialable water in the river and other considerations. The motors provide the power necessary to make up the load which the waterwheels cannot deliver. This system of combination drive is controlled by a load regulator which is actuated by changes in motor load.

To provide room for installing the motors on the two new grinding lines a section of the grinder room was extended over the tailrace as shown in the diagram. The outer end of this extension is supported on three circular piers in the tailrace, where the water is about 20 ft. deep. The piers were constructed by first sinking 6-ft. corrugated steel pipes to rock in the bottom of the tailrace. Before sinking the pipes, soundings were made to determine the contour of the rock and the lower end of the pipes were cut to conform to it. After the pipe was driven home it was pumped out, and any leaks sealed on the outside. Then the rock was cleaned and drilled to anchor the piers in place and the pipes were poured full



Island Falls plant has four 12,000-hp. units and supplies power to the pulp and paper mill at Iroquois Falls. In addition to this plant there is Twin Falls with five 6,000-hp. units and the grinder room at Iroquois Falls with fourteen 2,000-hp. waterwheels driving grinder lines

of concrete. Thus they serve the double purpose of caissons and forms for the concrete. This method of construction also allowed working in the tailrace without interfering with the operation of the waterwheels.

Power for driving the grinders regulates the requirements for water flow in the river. The problem of controlling this flow, when it is desired to conserve water, is complicated by Black River, which has very little regulation and flows into the Abitibi between the Twin Falls and the Iroquois Falls plants. Also the Island Falls plant is 85 miles, about 36-hr. flow, below Iroquois Falls. Consequently there is a large quantity of water in the river between these two plants. At least part of this water must be used for power generation at Island Falls plant when the mill is shut down over the week-end or it will flow to waste over the spillway.

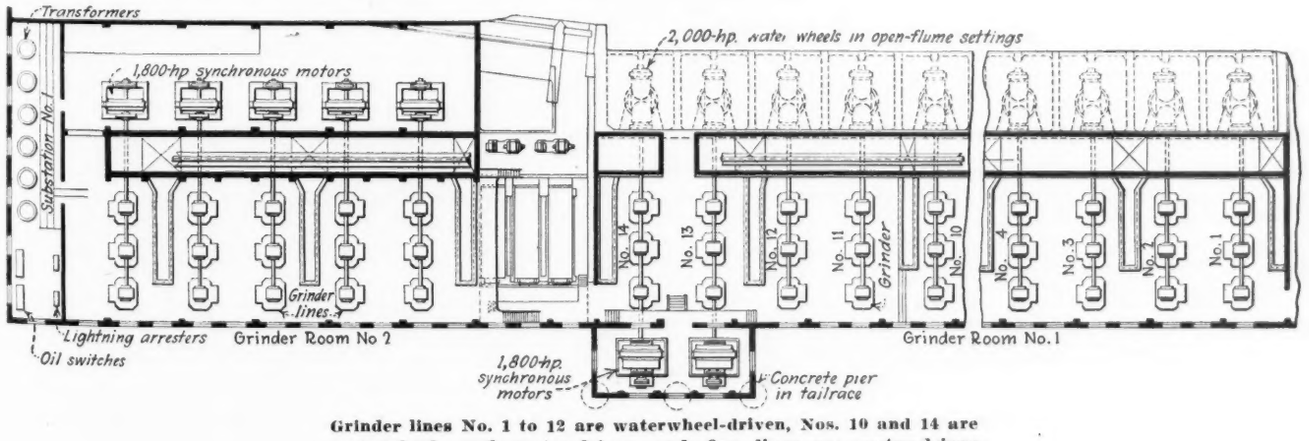
In the grinder room a balance is maintained between the electrically and waterwheel-driven grinders, so as not to waste water over the spillway, by adjusting the load on the two units driven by waterwheels and motors. If the flow from Black River is large, less water will be required through Twin Falls plant to maintain a balance at Iroquois Falls. Under these conditions the waterwheels on the two grinders, with the combination drive, may carry all the load and the motors float on the line for power-factor correction.

Taking the load off these two motors allows an equal decrease of load and water at Twin Falls. If it is desired to further reduce the load at Twin Falls, such as in flood periods, when there is more than sufficient water coming into the river below the lake to supply the power requirements, Island Falls plant is made to take a larger share of the mill's electrical load.

As the amount of water decreases in the river below that required through the wheels driving the grinders, as indicated by a decreasing head at that plant, more load is picked up on the motors of the combination driven grinders. This is reflected back to Twin Falls in a demand for more power and the release of more water. Sixty-cycle load may also be transferred from the Island Falls plant to the Twin Falls system to help maintain the proper flow in the river. It is also possible to hold the water in storage at Twin Falls and transfer the 60-cycle power load to Island Falls. This is done over the week-end, to utilize the water stored in the river between Iroquois Falls and Island Falls and which cannot be held in the forebay at the latter.

A large tank is provided for storing ground wood during the week-end shutdown of the paper mill. When the paper mill is closed down a sufficient number of motor-driven grinders are operated to absorb the power that must be generated in Island Falls plant to prevent spilling water. When starting up on Monday morning ground wood is taken from storage and only the waterwheel grinders are operated until the flow in the river has had time to equalize, when normal 60-cycle load can again be picked up at Island Falls plant.

The author extends his thanks to H. J. Buncke, chief engineer, Abitibi Power and Paper Company, Toronto and to E. M. Little, Assistant Mill Manager, Iroquois Falls Division for their assistance in the preparation of this article.



Grinder lines No. 1 to 12 are waterwheel-driven, Nos. 10 and 14 are waterwheel- and motor-driven and five lines are motor-driven

LABORATORIES INSTALL CRITICAL-PRESSURE BOILERS

While the highest steam pressure employed in an American power plant is 1,400 lb., the desirability of exploring the field up to the critical pressure is such that both Purdue University and Yarnall-Waring Company have installed units designed to be operated in tests over this range. Pressures as high as 3,700 lb. have been attained on the Purdue boiler

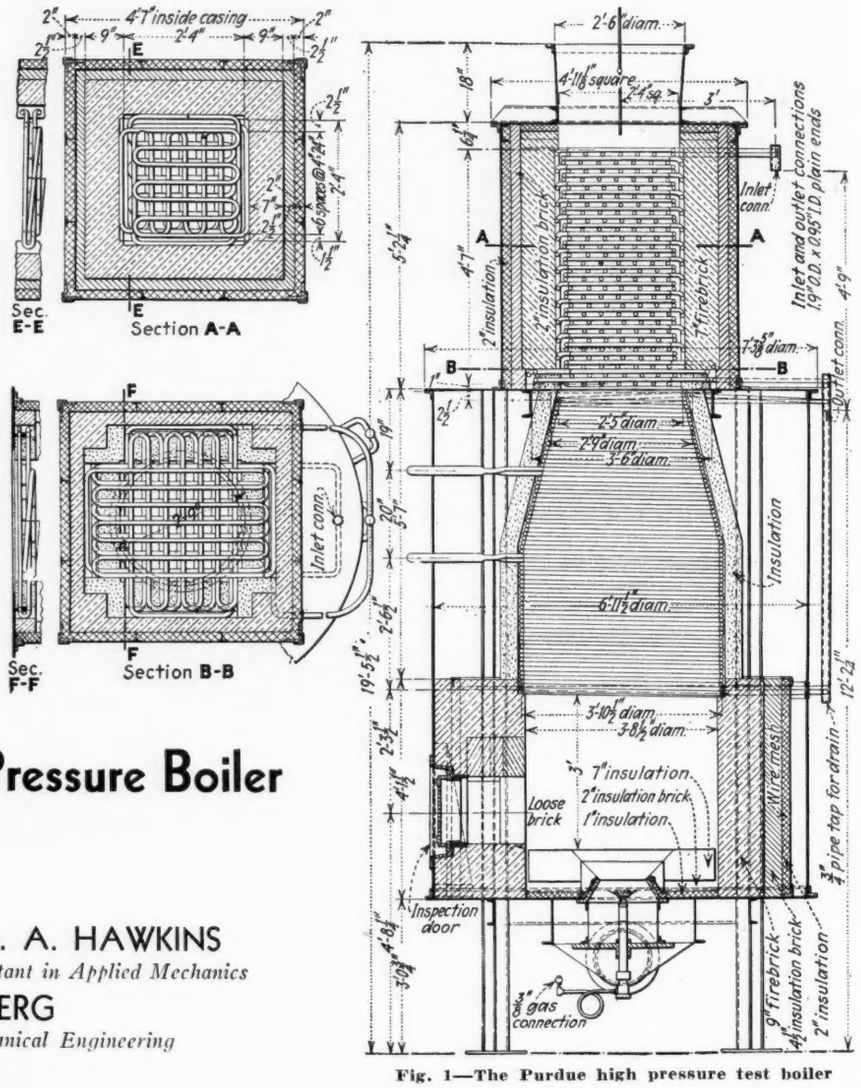


Fig. 1—The Purdue high pressure test boiler

The Purdue High-Pressure Boiler

By

A. A. POTTER
Dean of Engineering

G. A. HAWKINS
Assistant in Applied Mechanics

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THE high-pressure boiler of today is still basically the same as that of fifteen years ago, although the use of economizers, air heaters and water-cooled furnaces has altered the arrangement of the heating surfaces. While present types of boilers could undoubtedly be built for still higher pressures by increasing the thickness of the parts, it is desirable from the standpoint of plant investment to develop a type of steam generator in which heavy drums, forgings and large pressure parts can be eliminated or at least reduced to a minimum. The high-pressure series steam generator installed at Purdue University is such a development.

The steam generator, Fig. 1, consists of a cylindrical water-cooled furnace placed immediately beneath a counter-flow economizer, or convection section. The water which enters the unit passes through a continuous circuit and leaves as superheated steam. Outlet pressures up to 3,500 lb. per square inch can be carried, and the same design of unit could be used for still higher pressures by the employment of suitable tubing of increased wall thickness. By varying the ratio of fuel to water at a given flow rate, the unit will discharge anything from warm water to 830 deg. F., superheated steam. The temperature is limited by the tube material used, but special alloy steels would allow operations at still higher temperatures. No throttle valves or other regulating devices are installed between the feed pump and the steam outlet.

A single Cuyama-type mechanical-atomizing oil burner is set in the floor of the cylindrical vertical furnace. The gases pass upward through the furnace and the single-pass convection surface to the stack. The heating surface, which consists entirely of a series of tubes in the form of coils mounted directly over the combustion chamber, is divided into a furnace wall, or radiant-heat-absorbing section, and an economizer, or convection section.

Feed water enters at the top of the convection section and flows downward, counter to the direction of gas flow, through two parallel circuits of equal length. This

section is composed of 56 flat coils nested one above the other, each coil having seven straight parallel horizontal runs on 4-in. centers joined at the ends by integral 180-deg. return bends. The terminating run of each coil is carried around the coil nest and into the second coil below it at the opposite corner. In this way alternate flat coils are connected into one of the two parallel circuits and the coils are further arranged so that the direction of flow of the water in the flat coils of one circuit is at right angles to that of the other circuit. The four flat coils at the bottom of this section are made with longer straight runs, which engage supporting members and thus carry the weight of the tube nest. Each of the two parallel circuits is 521 ft. in length and is connected into a common equalizer, or downcomer, at the lower, or discharge, end.

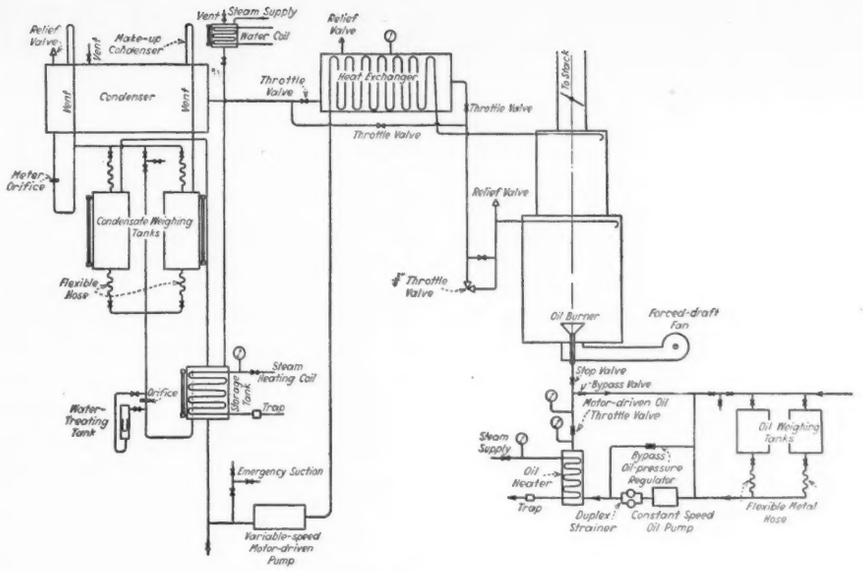


Fig. 3—Diagram of the testing equipment

Water from the convection section enters the furnace wall section at its low point and flows upward through two parallel circuits of tubes wound around the combustion chamber. The lower furnace wall section is wound in the form of a cylindrical helix, with sixteen complete turns in each of the two circuits. These circuits discharge into a common equalizer made of $1\frac{1}{2}$-in. double-extra-heavy seamless steel tubing with a forged steel "Y" fitting welded to each end. This equalizer discharges into the two parallel circuits in the upper furnace wall section. These circuits are wound in the form of a conical helix, with eighteen complete turns in each circuit and with a second equalizer connection at the end of the tenth turn. The two circuits are connected into a common header at the outlet.

The heating surface of the steam generator is distributed as follows:

Area of convection section, sq.ft.	259
Surface area of furnace wall section, sq.ft.	101
Projected area of furnace wall section, sq.ft.	64.5
Volume of furnace, cu.ft.	84.4
Distance from furnace floor to convection section, in.	110

This heating surface is composed of seamless steel tubing 1 in. outside diameter by 0.5 in. inside diameter, made of tubes of convenient mill lengths butt-welded by acetylene torch. The material of these tubes conforms to the specifications for seamless steel boiler tubes, 1927 edition of the boiler code of the A.S.M.E. The inlet and outlet headers and equalizers are of double-extra-heavy $1\frac{1}{2}$-in. medium-carbon grade open-hearth seamless steel pipe.

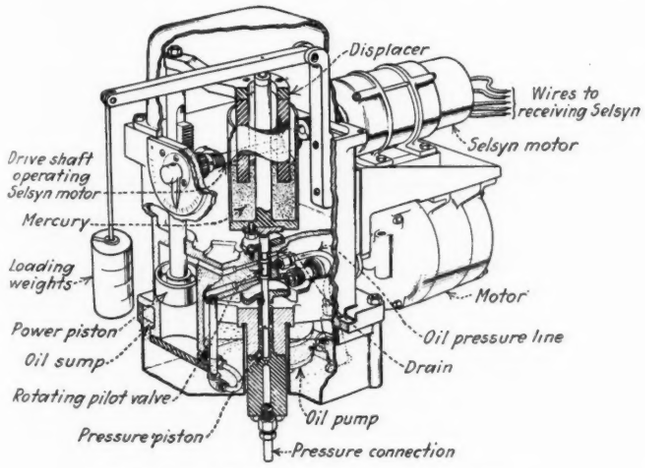


Fig. 2—The Bailey Power-type pressure gage

As will be seen from the diagrammatic layout of the installation, Fig. 3, feed water is supplied by a triplex pump driven by a direct-current variable-speed motor. The feed water from the pump discharge is heated in a special heat exchanger by the steam leaving the generator. From the heat exchanger the live steam enters a condenser of the steel tube floating-head type, designed for a pressure of 100 lb. The condensate is weighed in closed steel tanks mounted on platform scales; these tanks are connected to the piping system by flexible hose. The condensate is checked by a flow meter.

Live steam from the laboratory header is passed through an auxiliary condenser for use as make-up water. On recommendation of the Babcock & Wilcox Company, trisodium phosphate is used to condition the boiler water. Tests are made on alternate days for total alkalinity, sodium phosphate and pH value of the water. Dissolved oxygen is also determined frequently.

The type of high-pressure valve and flanges employed is shown in Fig. 4. The ring type of lap joint with a soft steel gasket of elliptical cross-section has proved satisfactory to date. A set of 2-in. companion flanges of this type at the boiler outlet was pulled up while warm by one man without sledging, using a 24-in. socket wrench, and it has shown no sign of leakage to date without any subsequent tightening of the studs. As the flanges have not been insulated, they are subjected to rapid temperature fluctuations, especially on shutting down, when the temperature changes from that of superheated steam at full boiler pressure to the temperature of warm water within five minutes after the oil supply is shut off.

Several 6,000-lb. standard screwed forged steel tees are subjected to the full steam pressure and temperature; $\frac{1}{4}$-, $\frac{3}{4}$- and 2-in. screwed conections of this type were made up with No. 3 Smooth-On iron cement without back-welding and have shown no signs of leakage at any joint.

Double-extra-heavy Class B seamless steel tubing is used for the feed-water piping, while a chromium

molybdenum steel-alloy tube is employed for the steam piping.

While the conventional type of steam generator has considerable energy storage in the drums and in the tubes, the series steam generator of Purdue University contains no drum, and the energy storage in the tubes is reduced to a minimum. Consequently, the accumulator action which exists in the conventional type of unit is almost eliminated. As a result, any system of control must function instantaneously to adjust the supply of fuel, water and air to the variations in output.

This generator differs further from the conventional type of unit in that no definite amount of surface is utilized to superheat the steam. By merely changing the fuel-water ratio the outlet temperature can be varied from saturation temperature to a temperature which is limited only by the characteristics of metals at elevated temperatures. It is necessary, therefore, that the control should function with temperature changes as well as with pressure changes. Moreover, variations in pressure affect the specific heat of superheated steam; and changes in steam temperature alter the specific volume of steam, and consequently, the pressure. As a result the control must hold both pressure and temperature variations within close limits to prevent the initiation of a hunting cycle. While the unit can be controlled easily by hand on a steady load, it is virtually impossible to take rapid and repeated swings in load with manual control, because of the difficulty of instantaneously changing the fuel, water and air supplies in the correct proportions.

The system of automatic control developed by the Bailey Meter Company for controlling this unit employs the Thyratron vacuum tube circuit. Changes in pressure operate through Selsyn motors, the contactors in the circuits of two Thyratron tubes which supply power to a reversing direct-current motor geared to the oil throttle valve. Temperature changes similarly control the speed of the boiler-feed pump by causing a reversing direct-current motor to operate a rheostat in the shunt field circuit of the motor. A Bailey oil flow—air flow meter proportions the air to the fuel by operating the contactors in the circuits of another pair of Thyratron vacuum tubes which supply power to the reversing direct-current motor that operates the fan damper. Changes in throttle position operate the contactors in the vacuum tube circuits of both the fuel and water supply systems.

It has not been possible to determine the maximum instantaneous load changes that can be handled by the control system, because of limitations in the speed variation obtainable from the boiler-feed-pump motor, a condition which is now being corrected. The maximum range of capacity obtainable with a given oil burner tip is about 2 to 1, but greater variations than this can be obtained by changing burner tips.

The Measurement of Pressures and Temperatures

The triplex boiler-feed pump used in this installation produces pressure pulsations which are quite severe and which continue well into the steaming zone. The accurate measurement of high pressures under such conditions requires a sensitive gage that will hold its calibration. A Bailey power-type pressure unit which is essentially a motor-driven self-loading deadweight gage is used for this purpose. (This apparatus was described in the April 4, 1931, number of *Power*).

The measurement of water and steam temperatures in a small thick-walled tube subjected to high pressures requires a device which is small, mechanically rugged and not subject to errors caused by heat conduction through the tube. The pyod type of thermocouple has been used for this purpose. When checked against the saturation temperature, as determined by pressure measurements, it was found that the original thermocouples read high by an error which increased with the rating and which amounted to as much as 6 or 7 deg. In the final design of thermocouples more metal was removed from the body of the pyod to improve the cooling at the hot junction. These thermocouples show little or no tendency to read high.

Operating Procedure

In bringing the steam generator up to operating conditions from cold the feed pump is started and its speed adjusted according to the flow meter to develop the capacity desired for the test. With the throttle valve wide open the fire is lighted and the oil flow is regulated to raise the pressure to 1,500 lb. and saturated steam in about 20 min. The throttle valve is then closed sufficiently to bring the pressure to within about 400 lb. of the desired operating pressure, after which the oil flow

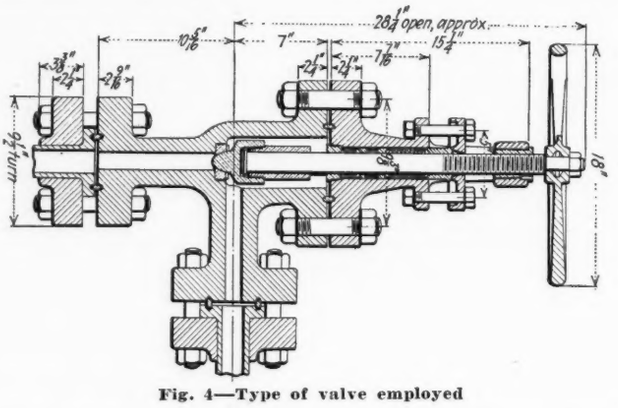


Fig. 4—Type of valve employed

is gradually increased to produce superheated steam. As the steam becomes superheated the pressure increases. An experienced operator can manipulate the controls to bring the unit up to operating pressure and temperature by the adjustment of the oil feed once the throttle valve is set. When the desired pressure and temperature are reached the automatic control is cut in and the unit will take care of itself. Normally, about 40 min. is taken to bring the cold boiler up to operating conditions and put it on automatic control, although it can be done by one man in 20 minutes.

In shutting down the unit the oil valve is closed, the dampers are shut and the boiler-feed pump is kept in operation. Within five minutes the steam gage will register the friction loss through the throttle valve and piping due to the flow of water. The pump is kept in operation for about 1½ hr. longer, or until the brick furnace is black and the final water temperature is under 250 degrees.

Experience gained when putting the steam generator into service indicates the necessity for careful design and construction of units having several circuits in parallel in order that the resistances of the circuits shall be equal or adjusted to give flow rates which are proportional to heat absorption. Some unbalance exists in the two parallel circuits in the lower furnace wall section, resulting in the discharge of slightly superheated steam into the equalizer from one circuit while the other one is discharging saturated steam. Pressure measurements

along the circuit in question have failed to show any localized point of high resistance. The unequal flow becomes noticeable only at high final steam temperatures and is not serious at any time.

Trouble has been experienced with the main steam throttle valve. The seat is made of Monel metal and is not damaged by steam-cutting, although the steam is throttled in this valve to a final pressure of about 50 lb. gage. However, the high pressure creates an unbalanced force which results in a mechanical galling or tearing of the valve seat when it is moved. As this is attributed to the softness of the metal, nitralloy seats will be tried in the near future.

The following series of tests has been conducted to date: 2,500 lb. pressure, 750 deg. F. steam temperature, variable capacity; 2,500 lb. pressure, constant capacity, variable superheat; constant capacity and final steam temperature, final pressures varying from 1,500 to 3,500 lb.; and 3,250 lb. constant capacity and variable steam temperatures.

The results of these tests are reported in a paper to be presented at the annual meeting of the American Society of Mechanical Engineers in December. The efficiency of the unit is between 60 and 70 per cent, depending on operating conditions. The automatic control system functions satisfactorily under all of these conditions of operation and the unit is easily handled and is stable throughout the entire range of pressures and steam temperatures.

This installation has been made possible for Purdue University through the generous cooperation of Babcock & Wilcox Company, Bailey Meter Company, Crane Company, Crosby Steam Gage & Valve Company, Commonwealth Edison Company, and Fisher Regulator Company. The investigations on this steam generator are being carried on in the Engineering Experiment Station of Purdue University and with the advice of a special research committee of the American Society of Mechanical Engineers on critical-pressure steam boiler research.

The Yarnall-Waring 2,500-Lb. Boiler

By D. ROBERT YARNALL

A HIGH-PRESSURE boiler has just been installed and placed in service in the new steam laboratory of the Yarnall-Waring Company, Chestnut Hill, Philadelphia, Pa. With 130 sq.ft. heating surface and 82 ft. furnace volume, it has been designed for the purpose of developing apparatus for power and industrial plants. The necessary characteristic which was incorporated in the design was the provision of a controllable water level at the highest pressures and temperatures likely to be met by such apparatus in the large steam-power stations now built and likely to be built in the next few years.

The boiler, built by the Superheater Company, is of unusual design, as will be noticed from Fig. 5, which shows a section through the assembled boiler and its accessories. The the best of knowledge, it is the only boiler built to date for 2,500 lb. working steam pressure that depends only on thermal circulation for the protection of the evaporative surfaces. This was chosen as the maximum working pressure because the Yarnall-Waring officials felt that the commercial range for high-pressure plants for the next ten years would probably be below 2,500 lb. working pressure. Moreover, the company's particular kinds of apparatus are concerned more with the water end of the boiler than with the steam end, since they are indicating and recording water levels, and hence a boiler that would definitely have a controllable but variable water level would be required for this type of development. It is for this reason that a boiler of the water-line type was decided upon rather than a boiler of the so-called flash design.

The evaporative surface is in the form of an ascending multiloop construction, the terminals of which are connected to the two drums. This eliminates all contraction and expansion strains at the points where the tubes are connected to the mud drum and the steam drum. The downcomers from the steam drum to the mud drum for feeding this evaporative surface are located out of the gas pass but inside of the setting to insure against any steam generation on the piping, thus eliminating any tendency for change of direction of flow in the evaporative surface.

In the generation of steam at 2,500 lb. pressure the steam bubbles are considerably smaller than at the lower pressures, therefore care must be exercised in the design of the boiler that the metal temperature be kept within a safe operating range, taking into consideration the metal used. This protection is obtained by fabricating the surface above in ascending multi-loop construction. The water is compelled to circulate continuously in the same direction. By so doing those parts of the heating system

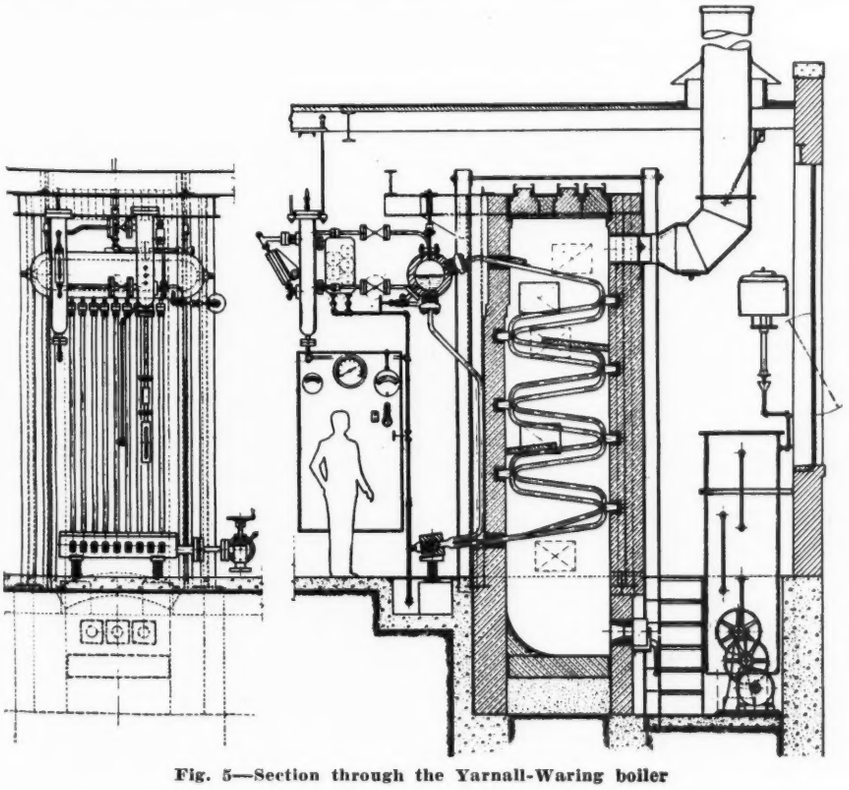


Fig. 5—Section through the Yarnall-Waring boiler

exposed to the greatest heat always have water present, and not until the gases have cooled down do they come in contact with the tube containing the mixture of steam and water. Thus a positive circulation is established.

The evaporative surface is joined to the mud drum by a rolled joint with handhole openings opposite, whereas the surface is joined to the steam drum by a special clamp construction, making a metal-to-metal joint and eliminating the necessity of handhole openings for making that joint. This type of joint was used on the steam drum to cut down the number of joints necessary due to the changes in temperature which may be expected on the steam drum. The steam drum, having an outside length of 5 ft. 10 in., an outside diameter of 18 in. and an inside diameter 12 in. (or 3 in. wall thickness), is made from a solid forging such as is used on most high-pressure boilers. The mud drum is also bored from a solid forging.

To relieve the boiler at 2,500 lb. a conventional type of safety valve is used, but for a series of tests at lower pressures extra springs were provided.

A series of different types of forged-steel water columns and high-pressure flat and round glass water gages are provided, as shown on the drawing. The blow-off valves installed for test purposes are of the forged steel seatless type, designed for high pressures.

City gas is used for fuel, the rate of combustion being automatically controlled by the steam pressure for the particular test being made at the time, the steam pressure itself being controlled for each test by an adjustable regulator.

In view of the small bore of the tubes which form the heating surface of the boiler, elimination of scale is important. For this purpose an evaporator has been provided, the condensate from which is stored in a vertical tank, shown at the left of Fig. 5.

▼

Are Diesel Fuel-Injection Principles Wrong?

DURING the past two years developments in high-speed diesels have been rapid, but unfortunately such engines as have been produced require a light fuel oil comparable to domestic heating oil and obtainable only at a price considerably higher than that of the heavy oil successfully employed in slow-speed diesels. Apparently, the heavier fuels will not burn rapidly enough to accommodate themselves to speeds of 1,000 r.p.m. and higher. This limitation prompts the inquiry, Are present injection methods wrong?

Whether one subscribes to the idea of complete vaporization before combustion or to the theory that burning occurs at the surface of the oil particle, vaporization must occur either initially or continuously at the oil droplet's surface. In high-speed engines the time interval is too short to permit either procedure to be accomplished completely as long as the fuel is injected as a spray of solid particles.

Some engineers have suggested that the solution lies in vaporizing the fuel prior to its introduction into the cylinders. Others contend that the time interval in an injection-after-compression engine is too short to permit thorough mixing of the gas and the air, since the penetration of the gas would be far less than that of oil particles. True, in gas-injection Otto-cycle engines, such as are now being built by several gas engine firms combustion is not perfect when the gas is injected late in the compression stroke. But in this case the injection gas pressure is low, say, thirty pounds, and the gas stream issuing from the spray valve has little velocity, and mixing is obtained only through the air turbulence. Injection must be early enough to permit the mixing to occur.

On the other hand, experiments with gas injection in diesel engines reveal that combustion is good. This is explainable on the grounds that the high velocity of the highly compressed gas results in a thorough mixing even in the short time interval in the diesel.

Undoubtedly prior gasification of the oil would improve combustion in the high speed diesel engines. The problem is one of gasifying this oil without undue carbon deposits in the heating element and of pumping the gas into the cylinder after compression. If the oil were heated at a pressure above the critical point, or to a temperature corresponding to the critical pressure, the fluid would have a volume but slightly greater than the volume of the oil. Cracking should not occur until the pressure is removed. Thus the action would occur in the engine cylinder, where the combustion temperature should prevent carbon formation.

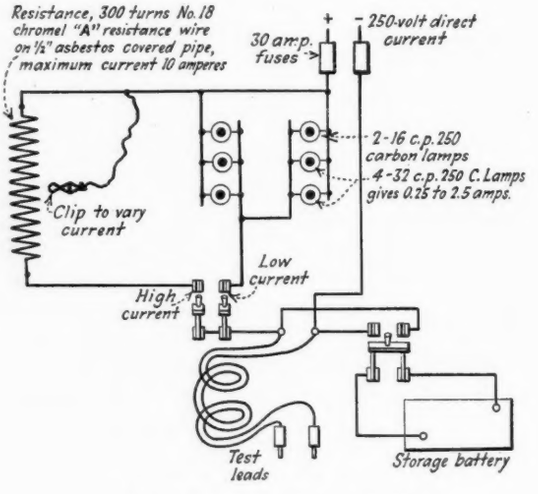
The difficulty of preheating the oil is not insurmountable; an electric element with temperature control should suffice.

▼

Panel for Testing and Battery Charging

THE DIAGRAM shows the connections for a handy 220-volt direct-current test panel. It may be used for low-voltage testing. The panel gives a current range on the test leads of 0.25 to 10 amp. with the battery switch open. Batteries can be charged by connecting them as shown and adjusting the current to the desired charging rate. This rate is varied either by the lamps for a low charge, or by raising or lowering the clip on the resistance, for a high charging rate. Without the clip connected the rate through the resistance only is about 5 amp.

A low voltage for testing is obtained through the test leads by opening the power supply switch and connecting a storage battery to the battery terminals. All wire on the panel is No. 12 asbestos-covered.


Resistance, 300 turns No.18 chromel "A" resistance wire on ½" asbestos covered pipe, maximum current 10 amperes
30 amp. fuses
+
−
250-volt direct current
2-16 c.p. 250 carbon lamps
4-32 c.p. 250 C. Lamps gives 0.25 to 2.5 amps.
Clip to vary current
Low current
High current
Test leads
Storage battery

Wiring diagram for test panel

CURRENT COMMENT

Educational Work of N.A.P.E.

MY ATTENTION has been called to the editorial, "Merit System Discarded," in the Sept. 22 number. While this editorial is correct in general, it is misleading in some very vital things.

A casual reader of the editorial might assume that the National Association of Power Engineers, which for the past 50 years has been primarily an educational organization among operating engineers, has finally decided to discard the fundamental principle of the organization, namely education. This would be far from the truth. The merit system adopted by the St. Paul convention of the N.A.P.E. in 1925 did not represent the first educational effort of this association. It represented what was considered, and still is, a plan that would admit of the average power plant operator's obtaining a technical education at a moderate cost and without loss of time from his work.

A great number of our members took advantage of the opportunity so afforded and benefited greatly thereby. It has, however, been apparent for the last three years that the overhead expense of this department of our educational work was out of proportion with the number of members actually deriving benefit therefrom. This fact, together with the necessary curtailment of expenses with which the association was admittedly confronted this year, made the action of the Kansas City convention the only possible course.

This does not mean that the National Association of Power Engineers has ceased to be what it has been since its inception, an educational institution. It does mean that the merit system has passed as a leading effort of the organization and that other means of education which will appeal to and reach a greater percentage of our members will be instituted in its place. To this end the educational committee of this body will work during the coming year.

L. A. PIERSON,
National President.

Detroit, Mich.

Why So Much Excess Air

THE OCT. 27 number of *Power* contained a letter from Robertson Matthews of Bolton, Ont., entitled "Why So Much Excess Air for Oil Engines?"

I wish to call attention to the misinterpretation of the importance of the vaporization process and the significance of the period of ignition lag by Kurt Neumann and others. During the ignition lag the fuel is heating up to the ignition point. Action is rapid, vaporization is small, but practically no oxidation occurs. From then on the vapor burns as fast as heat can evaporate the particle; this is facilitated by the heat of combustion and the removal of the vapor pressure of the fuel by combustion. We can speed up the combustion process by heating the fuel to the ignition point outside of the combustion chamber. Inasmuch as the time for the ignition lag is of the order of six-sevenths of the whole time from injection to substantially complete combustion, combustion can be speeded up by such a process. The amount of excess air can be reduced if we can secure complete combustion in the time available.

Further heating of the fuel, to be specific, to about or above the critical point, produces a true gas, without substantial chemical change for many fuels, as defined by the physicist. Others insist on calling it vapor. Its density is about one-third that of the liquid if the critical pressure or higher is maintained. The critical temperature is defined as that above which no pressure, however great, can condense the gas to a liquid. If this sort of fuel is injected into the engine cylinder the temperature for most hydrocarbon fuels will be above the ignition point, while the degree of subdivision will be essentially infinitely superior to that produced by injection of a liquid under high pressure. It is easy to show that a drop of the gas, allowing for condensation on expansion, cannot contain more than 32 molecules, while a drop 0.055 mm. (0.002 in.) in diameter contains 10^{11} times as many molecules. Obviously the rate of chemical action, on the basis of surface alone, will be between 1,000 and 10,000 times as rapid as for liquid particles. The greater temperature will have its effect. It should be possible, using this line of attack, to secure combustion as rapid as any practicable engine may require and permit of utilizing any particular cycle that may be desired. At present many engines are limited by the ignition lag and early injection to an essentially constant volume card with pressures of 1,200 lb., and a large excess of air for smokeless combustion. The proposed method makes combustion so rapid that practically complete combustion may be secured in the short time available with only a few per cent of air in excess.

Though cracking occurs if the heat is applied long enough in the case of certain fuels, the phenomena can be controlled without serious difficulty, as any number of related processes demonstrate.

Retaining 100 per cent excess air is more of a prejudice. The suggestion of lower percentages led one engineer seriously to raise the question of higher temperatures and temperature stresses, entirely overlooking the fact that such temperatures are somewhat limited by dissociation, and occur in gasoline engines. Heat stresses are, of course, less for smaller cylinders. With slow combustion, the excess is virtually necessary. Of course, the leaner mixtures offer higher efficiencies in the cylinder, after allowing for actual gases used; but the same applies to gasoline engines, though not to the same degree. The leaner mixtures in the diesel, as at lower loads, by their higher efficiency, tend to maintain fuel consumption per horsepower down nearly to quarter load.

Mr. Matthews' suspicions that fuel spray research has been greatly overdone is correct. That was obvious to me many years ago. The theory of fuel droplets so formed should have been sufficient to have led to other lines of attack without the enormous expenditures, substantially uselessly, by our National Advisory Committee for Aeronautics, as well as abroad.

I have found that most research workers turn in tolerable reports, but usually miss anything of fundamental importance. Unfortunately, their conclusions are the results usually remembered. If their experiments were remembered, the conclusions forgotten, I think we should make more rapid progress, for then every man using the data would have to do some real thinking for himself. In school they never wanted to have us look the answer up in the back of the book, for we then merely tried to get the answer without seeing why. Most of those who did not see why graduated, and, of course, now read the conclusions in research reports.

Bethlehem, Pa. EDWARD ADAMS RICHARDSON.

READERS' PROBLEMS

Conducted by L. H. MORRISON

PIPE LINE AS A REDUCING VALVE—*Steam is generated in a boiler at 165 lb. abs.; then* $H = h + L = 338 + 857$, *or heat of liquid plus heat of evaporation is 1,195 B.t.u. per pound, assuming dry and saturated, the temperature being 366 deg. F.*

The steam is then transmitted through a 100 per cent lagged pipe line so that radiation losses do not exist, thence through a reducing valve into a pipe heating coil immersed in a still, where the steam is condensed. The absolute pressure at the coil is 80 pounds.

Since there has been no external work accomplished and no radiation loss, the total available heat H per pound is 1,195 B.t.u. per pound and the condition of the steam at the steam coil is $H = h + L +$ *Superheat at 80 lb., or* $282 + 11 \times 900 + 13 = 1{,}195$ *B.t.u. with the temperature at 337 deg. F. In condensing, the steam gives up* $1{,}195 - 282 = 913$ *B.t.u. per pound.*

Hence, may we not say, that, assuming the theoretical 100 per cent lagged pipe line, the available heat in the steam per pound at 80 pounds absolute is the same as at 165 pounds absolute?

The result of the pressure drop is a change in the internal energy of the steam, that is, the steam if introduced into an engine at 165 lb. would accomplish more external work per pound of steam than if the steam were first passed through a reducing valve to 80 lb. abs. into the same engine, assuming no radiation losses.

How does one find out the change in internal energy?

Referring to Marks & Davis steam tables, at 165 lb. abs., $E = 1{,}111.3$ *B.t.u. per pound; at 80 lb. abs.,* $E = 1{,}101.6$ *B.t.u. per pound. Does this represent the change in internal energy?*

From a practical standpoint, in laying out pipe lines for steam process work where engines are not involved but merely for heat, is it not more economical to permit the pipe line to be a reducing valve in itself and to use a steam velocity of about 8,000 ft. per minute, with the pipe line well lagged? S.E.N.

The internal work at any steam condition may be found by finding from the steam tables the total heat at this state and deducting from this heat H the external work E necessary to bring the steam to the condition from 32 deg. feed water. E is equal to the pressure X volume change, or $E = \frac{144\ P\ (V_1 - V_2)}{778}$

where

V_1 = Steam volume at stated pressure and superheat.

V_2 = Water volume.

P = Pressure, lb. per sq.in.. abs.

In the steam tables the internal energy is given for saturated steam, but for superheated steam it is necessary to calculate it from the known total heat and the volume change.

For example, at 165 lb. the internal energy is 1,111 B.t.u. At 80 lb. pressure and 337 deg. total temperature the total heat is, as given in the question, 1,195 B.t.u. The volume of a pound of water is approximately 0.017 cu.ft. and the volume of a pound of 80-lb. superheated steam is, from the steam tables, 5.7 cu.ft. The external work is then $144 \times 80\frac{(5.7 - 0.017)}{778} = 85+$ B.t.u. The internal energy at 80 lb. is then $1{,}195 - 85 = 1{,}110$ B.t.u.

However, the problem should be approached from the basis of the total heats and the availability of the heat. In the steam engine the reason the 80-lb. steam will not deliver as much mechanical power is that as the total heat is the same after expansion from 165 to 80 lb., the entropy is increased at 80 lb., and the availability of the heat in steam is in inverse ratio to the entropy.

The pipe line actually acts as a reducing valve, and if the line is 100 per cent lagged, which is, of course, impossible, all the heat remains in the steam. As to whether it is more economical to lag the pipe line and depend upon the frictional resistance to give the drop or to reduce the velocity and use a reducing valve depends upon the kind and amount of lagging. There is an economic thickness of lagging for any given set of conditions.

LIQUID TEMPERATURE INDICATOR—*What liquid would be the best for a pressure range from 1 to 150 lb. and a temperature range of 150 to 350 deg. F. The pressure change with a temperature change should be perceptible.* W.R.W.

The best liquid would be water. A temperature of 150 deg. F. will give a vapor pressure of 3.7 lb. abs., and at 350 deg. F. the vapor pressure will be 124 lb. abs. The variation is, roughly, one pound per degree of temperature change.

HYDRAULIC ELEVATOR SPEED—*How is the car speed of hydraulic elevators regulated?* F.M.

On the horizontal type two methods are used: First, by increasing or decreasing the length of travel of the controlling valve; second, by opening or restricting the perforations through the valve sleeve. The latter plan is the better in most instances. By shortening the travel of the main valve the speed of the car may be decreased, but since shortening the travel does not necessarily influence the speed of the valve travel this method of stopping the car may be too abrupt. The opening or restricting of the perforations in the valve sleeve controls the volume of water flowing from and to the cylinder without influencing the speed of the valve travel, and more satisfactory starts and stops are possible when the machine's speed is governed by adjusting the valve sleeve. On other types the speed is limited either by pilot-valve travel regulation or by governing valves in the circulating pipe.

STEAM VELOCITY IN HEATING SYSTEMS—*We have an industrial heating system using saturated steam of 10 to 40 lb. gage pressure, regulated in accordance with outside temperature. The radiators are made of pipe coils and are equipped with a standard bucket-type steam trap each. The condensate return line leads to a pump receiver vented to the atmosphere. Additional radiators are to be installed and the question arises whether the present pipe sizes will be sufficient to carry the additional steam and condensate.*

Statements in textbooks as to the proper allowable velocity of heating steam and condensate in pipes are highly conflicting. What would you consider reasonable maximum velocities? K.F.B.

The allowable maximum velocity will depend upon the pipe diameter; using Babcock's formula

$$W = 5{,}220\sqrt{\frac{PD\ d^5}{\left(1 + \frac{3.6}{d}L\right)}}$$ in which

W = Pounds of steam per hour.

P = Loss in pressure in pounds per sq.in.

d = Inside pipe diameter, in.

L = Length of pipe, ft.

D = Weight of 1 cu.ft. of steam at existing pressure,

and assuming a pressure drop, the weight of steam flowing and the maximum velocity may be calculated. With a pressure drop of 10 oz. per 100 ft., the velocities in feet per second for various pipe diameters are as tabulated. Velocities higher than these are not recommended.

Pipe Diameter In.	Steam Velocity, Ft. per Sec.
2	99
3	135
4	166
6	216
10	312

POOR CIRCULATION IN HOT-WATER LINE—*We have a hot-water storage tank in the basement, and the water is taken from the bottom of this line and put through the water back of a range on the floor above. The hot water returns to the top of the storage tank, into which also passes the cold water supply through an interior pipe. The circulation is bad. What can be done to improve it?* C.H.W.

Wherever the hot water storage tank is placed in the basement below the source of heat, which in your case is the waterfront of a range, circulation is inclined to be sluggish, for the reason

that the line leading from the bottom of the tank to the range has water in it that is cooler than is the water in the line leading from the range back to the tank; consequently there is no inducement for a circulation to be set up from the bottom of the tank to the waterfront and back to the top of the tank.

To correct this, you should run a line from the outlet of the waterfront up to the ceiling, and then back down to the top of the water tank. The height above the waterfront of this loop should be equal, if possible, to the distance from the waterfront to the bottom of the tank. Also, the line from the bottom of the tank to the range, or waterfront, should be one size larger in diameter than the return line.

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Water Level in Jet Condenser Automatically Maintained

THE PREVIOUS QUESTION

WHEN OPERATING a low-head multi-spray jet condenser, where should the water level in the casing be kept, that is, how far below the vacuum breaker float chamber?

C.B.

ONE NEED not place any material significance upon the amount of submergence carried in a jet condenser. It is well, however, to carry the water level as nearly two or three inches above the lower end of the combining cone as is practicable. This level should be about half way of the water gage glass. At this point there is no danger of the water-removal pump vortexing, thereby reducing its capacity, and it also permits better separation of the air from the water.

The water traps the air in its downward flow, and by its velocity carries the air under the water in the condenser. As the absolute pressure behind the combining cone is less than that in the mouth of the condenser, the air follows the path of least resistance, separating from the water, behind the cone, and finds its way more readily to the air vent leading to the air pump.

If the water is carried too low the removal pump will vortex, taking in some air, and its capacity will be reduced. However, in practice, as the vacuum increases more water is drawn through the nozzles, and the water level rises. This reduces the vacuum and increases the pump capacity, which, in turn, reduces the water level. The pump begins to lose its capacity by vortexing and taking in air. This extra removal of air increases the vacuum, and the cycle is repeated, thus keeping a uniform water level and vacuum. If the water is carried too high the air is inclined to come up inside the cone, thus breaking up the extended flow.

LEONARD LONG.
Detroit, Mich.

IN CASE C.B. has in mind a condenser of the multi-jet type, Fig. 1, there is no water level maintained in the condenser chamber, as the condensed steam is discharged with the high-velocity water jets through the tail diffuser at the bottom of the condenser body into a hotwell below, the energy of the water jets discharging a mixture of water and non-condensible gases against the external atmospheric pressure. This kind of condenser has a float-type vacuum breaker near the bottom of the condenser chamber, acting as a safeguard in case the injection pump should fail and the vacuum tend to draw the water back through the tail diffuser.

On the other hand, a low-level jet condenser using sprays, an external vacuum pump and water-removal pump in the base of the condenser chamber, Fig. 2, maintains the water level a few feet above the centerline of the pump shaft. This level fluctuates slightly with variations in the steam load, causing changes in the vacuum and in the rate of flow of the injection water. It is obviously desirable to maintain the water level as far as possible from the vacuum breaker, the latter being in the upper part of the condenser body.

However, the height of water level in such a condenser adjusts itself automatically according to the vacuum and pump speed maintained; therefore the vertical distance between this level and the vacuum breaker is primarily a question of design. If the breaker is placed close to the top steam inlet of the condenser there is danger of flooding the turbine in case the removal pump should fail. If it is placed too low, the fluctuating water level may cause the breaker to open and destroy the vacuum under normal load variations.

Care should be taken to admit just enough injection water to the condenser to maintain the highest vacuum for a given steam load and water temperature with the lowest possible water level in the condenser chamber. In other words, the quantity of injection water should correspond to the capacity of the removal pump.

R. E. HELLMER.
Philadelphia, Pa.

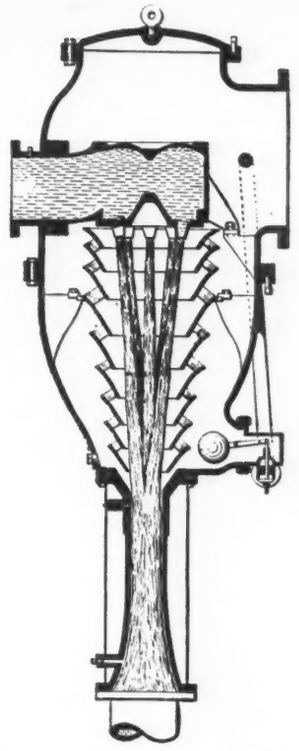

Fig. 1—Multi-jet pump employing kinetic energy to remove the condensate and condenser water

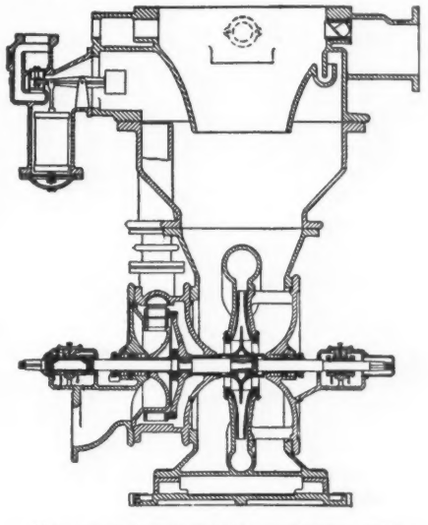

Fig. 2—A low-head jet condenser provided with a removal pump

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A Question for Our Readers

I SHOULD like to have from POWER'S *readers data as to the relative merits of white lead and red lead as a pipe-jointing compound for brass pipe and for galvanized pipe. I have had some ideas about this matter for some time, but I must admit that they are based on what seemed to be good practice and not directly upon any authoritative information on the subject.*

H.C.R.

Suitable answers from readers, if received promptly, will be paid for when published.

THE ENGINEER'S

British Coal Data

THE PREPARATION, SELECTION AND DISTRIBUTION OF COAL. *Compiled and published by The Coal Trade Luncheon Club and The Institute of Fuel, 53 Victoria St., London S.W.1, England; 1931. Cloth, 6x9 in.; 182 pages; illustrations, charts and tables.*

THIS BOOK treats of the production, preparation, distribution and utilization of coal in Great Britain. It presents a progressive picture of coal—what it is and how it is used—for the information primarily of those actively engaged in its production and use.

The first chapter, dealing with the origin of coals, contains an interesting discussion of the Vitrain, Clarain, Durain and Fusain structures identified by Stopes and generally accepted as applying more to the bituminous coals of Great Britain than to those in the United States. Classification and analysis are also discussed, along with the Gray-King assay method, which is being recognized in this country as an accurate source of data on the carbonization characteristics of various coals.

Succeeding chapters deal with the British coal fields, mining methods, transportation and distribution. A chapter on preparation for market takes up the various methods in use and covers the subject of washing in some detail.

Under the section on utilization, considerable information is given on domestic usage. The American reader is impressed with the extent to which coal is used on open grates, a use that has received little or no attention in this country. The carbonization of coal and the effect of the characteristics of various coal types on their efficient use under different burning and carbonizing methods are also treated.

The book is clearly and simply written, each subject being discussed by an authority. While dealing primarily with British coals and methods, much of the contents should prove helpful to anyone desiring a readily understood, authoritative introduction to coal and its usage.

The Way to Good Health

YOUR HEALTH AND YOUR EARNING POWER. *Published by the National Electric Light Association, 420 Lexington Ave., New York City; 1931. Cloth, 5x8½ in.; 180 pages, illustrated. Price, 65 cents.*

EMPHASIZING the fact that a very large percentage of human illness is due to indifference or ignorance or both, and is easily preventable, this book sets forth the simple, sane rules of living that lead to good health with all its inestimable benefits. It was prepared by the Health Promotion and First Aid Subcommittee of the Industrial Relations Committee, Public Relations National Section of the N.E.L.A., to combat the deplorable condition, shown by government reports, of wage earners in this country losing through illness 250,000,000 working days each year. Such a condition, the authors state, is "greatly to our discredit."

Chapter I describes the mechanism and structures of the human body and, while brief, might very well serve as an excellent text on physiology. Chapter II takes up the question of food and the process of living, classifying foods, discussing the quantity of foods which should be eaten and balanced diets, concluding with directions as to diet.

Chapter III deals with correct living habits, including such subjects as mental attitude, periodic health examinations, exercise, posture, rest and sleep, relaxation, recreation, value of sunlight and fresh air; while the next chapter discusses personal hygiene. From this point on the authors go into some detail as to disease prevention, first aid in sickness, care of the patient and first aid to the injured, including a full description of the Schafer prone-pressure method of resuscitation in cases of gas poisoning, electric shock and drowning, which has been so widely adopted by governmental utility and industrial organizations in this country.

Written in simple and understandable language, the book is a gold mine of health information, which, once acquired, should prevent many of the more common human ailments. The N.E.L.A. and its subcommittee is to be greatly commended for this valuable contribution to a subject of vast importance to everyone desiring a full, rich life.

Materials Standards

A.S.T.M. TENTATIVE STANDARDS, 1931. *Compiled and published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Cloth or paper, 6x9 in.; 1,008 pages; illustrations, charts and tables. Price, cloth $8, paper $7.*

1931 SUPPLEMENT TO BOOK OF A.S.T.M. STANDARDS. *Paper, 6x9 in.; 144 pages; diagrams and tables. Price, $1.50.*

AN ANNUAL PUBLICATION, the book of "A.S.T.M. Tentative Standards" this year contains 180 tentative specifications, methods of test, definitions of terms and recommended practices, of which 44 relate to metals and 136 to non-metallic materials. Although these tentative standards are in the trial stage of A.S.T.M. procedure, they represent the latest thoughts of the committees on these subjects, and as such are being applied in many industries.

In the ferrous metals group are specifications for riveted-steel and wrought-iron pipe, various types of welded steel pipe, forgings and structural steel. Included in the non-metallic group are tentative specifications for electrical wire and cable insulation, a test for laminated sheet insulation and one for comparing the thermal conductivities of solid insulating materials.

The 1931 Supplement to the "Book of A.S.T.M. Standards," which is issued only every third year, contains 32 standards adopted or revised by the society on Sept. 1, 1931. Seventeen of the standards are new ones, and fifteen are replacements of existing standards. They include specifications for alloy-steel bolting materials used in high-temperature service, welded wrought-iron pipe, high-test gray-iron castings and electrical insulation. Standard definitions of terms relating to refractories and to structural clay tile are also given.

Vibration and Noise

NOISE AND VIBRATION ENGINEERING. *By Stephen E. Slocum, consulting engineer. Published by the D. Van Nostrand Company, 250 Fourth Ave., New York City; 1931. Cloth, 6x9 in.; 158 pages, 74 illustrations. Price, $2.75.*

THE AUTHOR devotes his attention to the elimination of building and traffic noise, and gives many illustrations of how buildings have been insulated against vibration, due to subway and machine operation. Building designers will find much information in the volume, but it is regrettable that the author did not give attention to the problem of elimination of vibration in the machine itself, as well as to that of prevention of vibration transmission.

Balancing Machines

THE BALANCING OF MACHINERY. *By C. Norman Fletcher. Published by Emmott & Company, Ltd., 28 Bedford St., London W.C.2, England. Cloth, 6x9 in; 167 pages; 99 illustrations. Price, 10 shillings.*

THE REVIEWER must confess to some disappointment in finding that this volume practically ignores the many problems of machine balancing, and merely covers broad descriptions of various balancing machines available at present. For those production engineers who are in search of balancing machines to correct defects in rotating shafts, the volume will be welcomed.

BOOKSHELF

A Saga of Progress

THE ROEBLINGS. *By Hamilton Schuyler. Published by the Princeton University Press, Princeton, N. J.; 1931. Cloth, 6x9 in.; 425 pages, illustrated. Price, $5.*

THIS BOOK is a record of the accomplishments of one family in engineering and industry in the United States—a family and an achievement that distinctly belong to the annuals of our history.

In his own words, John A. Roebling, in coming to America, "was animated by no mean spirit of adventure; he looked for another homeland where conditions were politically freer and opportunities for advancement less restricted." He found them—and success and fame to boot.

A century has elapsed since the brothers Roebling, with the small band of German colonists which they had organized, settled in Saxonburg, near Pittsburgh. For John, then about 25, there followed two years of real estate promotion and hard work, while the primitive settlement was turned into a thriving farming community.

His story from earliest days is full of glamorous details. Born in Mulhausen, Germany, 1806, with a family tradition in the middle-class manner—comfortable, respectable, approaching distinction in spots. His mother seems to have been a woman with a "long view"; his instructors in gymnasium, realschule and later at the Royal Polytechnic Institute in Berlin, were brilliant men—well-known experts in their lines. At the University of Berlin, while pursuing special modern language courses, he attended lectures by Hegel, the famous philosopher. Family tradition says that Roebling was his favorite pupil. Under Hegel's influence he early saw "the spiritual reality back of the change and decay of material phenomena." Metaphysics and music became his dissipations, but bridge construction, even at this early period, was his preoccupation. During the first working assignment after his institute days he took time off to make an inspection of the "miracle" bridge, suspended by chains, over the River Regnitz in Bamberg, and at once became ambitious to do something original along these lines.

With this background of training and experience, plus a dream, Roebling arrived in America. It was the psychological moment. The United States, with enormous resources awaiting development and but little or no native scientific knowledge, was glad to welcome trained young men from the technical schools of Germany, so well equipped to handle her pressing problems of transportation, mining, manufacturing, etc. Her needs coincided with young Roebling's ambition. In 1837, the same year in which he became an American citizen, he was given a state engineer's job on canal construction. There followed inclined railways, a suspension aqueduct or two and finally the opportunity to build a bridge, over the Monongahela River at Pittsburgh.

There followed the Niagara River suspension bridge—the first railroad suspension bridge. Then Brooklyn Bridge—the supreme conception of his last days, becoming the great achievement of Washington Roebling, his eldest son, and so on through the long list of bridges, cable-equipped and erected "by Roebling": Williamsburg, Manhattan, Bear Mountain and last and most noteworthy, the George Washington—all monuments to the genius and skill of the company of John A. Roebling's sons and grandsons. Side by side was the enormous growth of the wire-rope industry in Trenton; enormous Roebling plants; the town of Roebling.

The story reads like the original fable of success and the stories of the individual men of this family who spelled the words along the way have somewhat the same fabulous quality. Generation after generation of the great inventor-engineer type, making a saga of progress.

Distinctly worth reading, this book. Biographical material on engineers is all too meagre. There are profuse illustrations; the men and the bridges are all there—a handsome lot of both.

The author has had access to the original family records, letters, diaries, etc., which have greatly added to the personal flavor of the biographical material. A great many of the technical details also, particularly those having to do with the erection of the Niagara River Bridge and the Brooklyn Bridge, are directly quoted from the daily records and diaries of John A. and Col. Washington Roebling, respectively.

Reviewed by R. M. BROWN.

BRIEF REVIEWS

ALTERNATING - CURRENT CIRCUITS. Second Edition. By John M. Bryant and James A. Correll. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 492 pages, illustrated; price $4.50.—This introductory text to the study of alternating-current circuits and transmission lines has been thoroughly revised in the second edition, with much new material added.

DIE ENTZÜNDUNG UND VERBRENNUNG VON GAS- UND BRENNSSTOFF-DAMPF-GEMISCHEN. By Dr. W. Lindner. Published by the VDI-Verlag, Dorotheenstr. 40, Berlin N.W. 7, Germany; 85 pages, illustrated; price 7.5 marks.—A critical summary of the latest information on the ignition and combustion of gas and vaporized-fuel mixtures.

TWENTY-FIFTH ANNUAL REPORT OF THE BENGAL SMOKE NUISANCES COMMISSION. Published by the Bengal Secretariat Book Depot, Writers' Building, Calcutta, India; 13 pages, illustrated; price 1 shilling.—An interesting account of the smoke abatement work in Bengal.

X-RAY EXAMINATION OF WELDED PRESSURE VESSELS. By A. J. Moses. Reprinted from *Combustion*, Sept., 1931, and issued by the Combustion Engineering Corporation, 200 Madison Ave., New York City; 8 pages, illustrated; free.—A discussion of the X-ray method of testing prescribed in the A.S.M.E. Boiler Code, together with description of the equipment used by the Combustion Engineering Corporation.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN DES GHH-KONZERN, No. 6. Published by the VDI-Verlag, Dorotheenstr. 40, Berlin N.W. 7, Germany; 24 pages, illustrated; price 3 marks.—Reports of the research laboratories of the Gutehoffnungshütte Konzern, dealing with metals and heat transfer through the heating surfaces of boilers.

STORIES OF WESTINGHOUSE RESEARCH. By Colin K. Lee and Hendley N. Blackmon. Published by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.; 48 pages, illustrated; free.—Brief, interesting sketches of the latest research activities of the Westinghouse laboratories.

THE 1931 BIBLIOGRAPHY OF MANAGEMENT LITERATURE. Compiled and published by the American Society of Mechanical Engineers, 29 West 39th St., New York City; price $2.—This book contains nearly 5,000 references to information on management, published in books and magazines in the United States, Canada and Great Britain during the past 28 years.

BELT DRIVES WITH CAST-IRON PULLEYS AND PAPER PULLEYS. By C. A. Norman and G. N. Moffat. Published as Bulletin No. 62 by the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 20 pages, illustrated; price 25c.—Contains data on the transmission efficiency of various types of belts used with cast-iron and paper pulleys, together with a critical analysis of the commonly used formulas for the effect of contact angle on transmissive power.

WHAT'S NEW IN PLANT EQUIPMENT

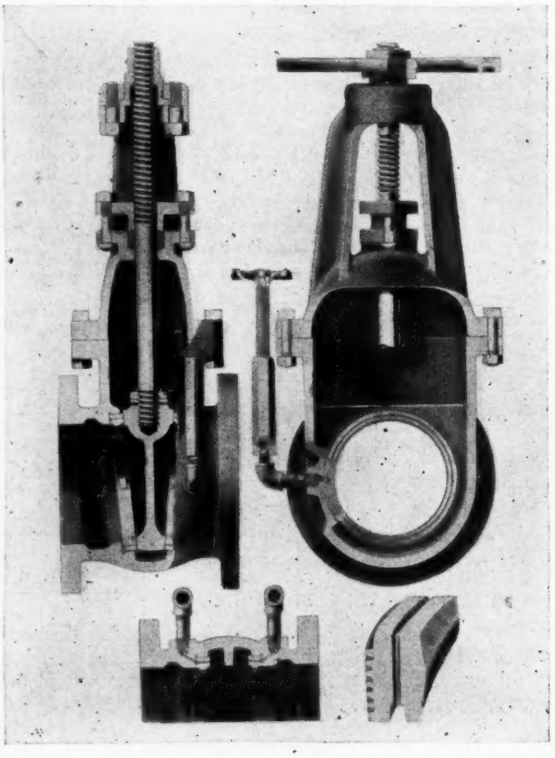
Gate Valves With Lubricant Seal

USE OF A lubricant seal between the seating surfaces characterizes a new line of gate valves, "Lubrotite," now being put out by the Reading-Pratt & Cady Company, Inc., Bridgeport, Conn.

Referring to the sectional detail of the body and seat ring in the illustration, it will be apparent that the lubricant is introduced around the sealing surface by a groove or duct in each side of the seat ring and a series of interconnecting holes. The lubricant is forced through the ducts by means of a screwed plunger on the side of the valve as shown.

One of the claims made for the valve by the manufacturer is that the valve is sealed tight even though the seating surfaces may have become damaged by scratches, deposits or corrosion in the line. Other advantages are given as easier operation, sealing surfaces do not become corroded or scratched as easily as non-lubricated surfaces, frees wedge that has become set from long period of service, and reduced wear on valve.

The new valves are made in standard and extra-heavy iron body patterns and in cast steel and are interchangeable with non-lubricated valves. They are designed for use on boiler-feed lines, blowoff lines, water systems, paper mill service and similar applications. Lubricant seals are supplied for various services: air, gas, water, chemical, petroleum products, etc.



Lubricant is forced between seating surfaces when valve is closed

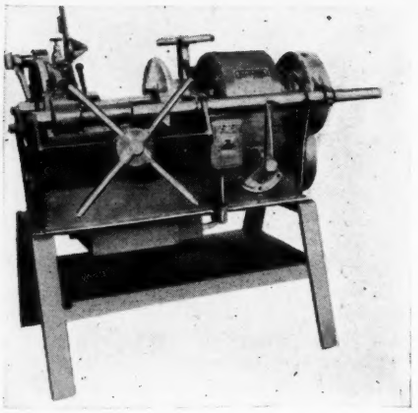
Wire Cable Tension Indicator

DESIGNED to measure the load on wire cables by the deflection principle without dead-ending or taking up slack, the tension indicator shown is made in two sizes: the standard model for cables between $\frac{1}{4}$ in. and $\frac{3}{4}$ in. in diameter and loads up to 16,000 lb.; and the heavy-duty model for cables from $\frac{3}{4}$ in. to $2\frac{3}{8}$ in. in diameter and loads up to 260,000 lb. A definite offset is made in the line between two fixed points and the force required to make or maintain this offset is shown on the gage—a direct indication of the line load. It may be applied to the line while already under load, prior to the application of stress.

At each end of the instrument adjustable clamps bring the line to a fixed stop. Between these clamps the line is offset by a projection carried by a pressure plate. This pressure plate bears against a flexible canvas-reinforced rubber diaphragm backed up by a body of fluid. The fluid pressure generated is a measure of the force required to maintain this offset.

The instrument is used for obtaining line loads on cranes, guys, transmission lines, etc., and for determining the pull on various types of hoists and elevators. It is put out by the Martin-Decker Corporation, 3431 Cherry Ave., Long Beach, Calif.

Indicator applied to cable



Toledo 1 to 4 in. power pipe machine

Power Pipe Machine

A HIGH-SPEED 1 to 4 in. power pipe machine, "Toledo" No. 1-2-4, is now being offered by the Toledo Pipe Threading Machine Company, Toledo, Ohio.

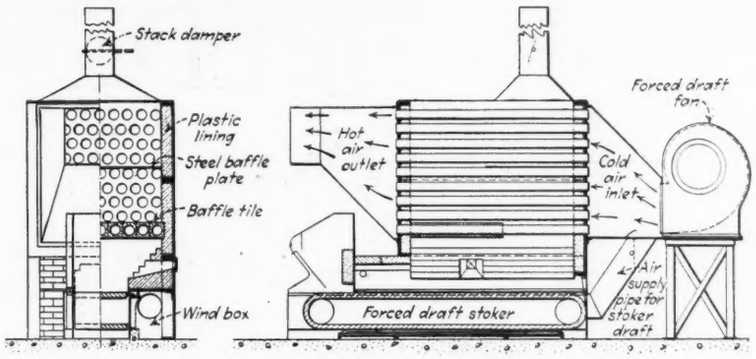
The machine has a frame of all-steel construction and is equipped with eight quick-opening die heads and dies—one for each size of pipe. The dies are the rake type and are easily reground. The cutter head is of special design with four high-speed steel cutter knives cutting simultaneously. The quick-opening die heads permit instant release of dies after threading.

The reamer is of the cone type, with single high-speed steel cutter blade mounted on an arm, which can be instantly swung into position for reaming, and fed by carriage handwheel. Left-hand dies can be furnished on order and the same die heads can be used for right- or left-hand sizes. Six spindle speeds are obtained instantly through one clutch lever and gear-shifting lever, and all controls are easily managed by the right hand.

A centrifugal oil pump positive in action gives ample flow of oil on the dies and cutter knives. The reverse is electrically controlled by the switch. Short nipples without nipple chuck may be produced, and the rear chuck is fitted with special jaws for gripping flanges, and pipe tong supports for screwing up fittings. It occupies a space of 2 ft., 11 in. x 3 ft., 10 in. and its net weight is 1,750 pounds.

Pressure Gage Vibration Eliminator of Stainless Steel

IN THE Feb. 17 number of *Power* the line of pressure snubbers (a device to eliminate vibration in pressure gages) put out by Ray Pressure Snubber Company, 311 East Fifth St., Charlotte, N. C., was illustrated and described. This line has been extended recently by the addition of a stainless-steel unit, designed for use with liquids and gases that have corrosive action on bronze. There are two types, one for thin liquids, such as ammonia and gases, and the other for heavy fluids. They are made in $\frac{1}{4}$-in. size and for pressures up to 2,000 pounds.



Sectional views of heating unit fired with chain-grate stoker

Self-Contained Heating Unit for Large Areas

DESIGNED especially for heating large shops and open structures, the heating unit developed recently by the Illinois Stoker Company, Alton, Ill., comprises a small chain-grade stoker and a hot-air unit through which air is blown by a standard-type 5,000-cu.ft.-per-minute blower.

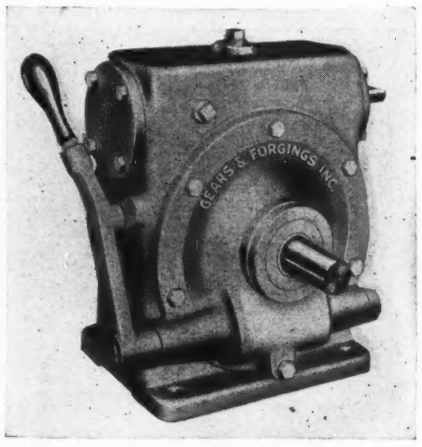
Dimensions of the unit are 5 ft. wide, 16 ft. long by 8 ft. high. It is pointed out by the manufacturer that no piping or other installation work is necessary other than providing a foundation, a stack connection and outlet connection to warm air ducts if distribution requires a division of the outlet steam of hot air into two or more ducts. The stoker is of the type regularly supplied for boilers from 500 to 2,500 sq.ft. of heating surface.

Across-the-Line Motor Starter

LIKE THE No. 1-ZO motor starter, the larger No. 2 Type ZO starter now being put out by the Electric Controller & Manufacturing Company, 2700 East 79th St., Cleveland, Ohio, is a self-contained unit, totally inclosed in a heavy pressed-steel case with oil-immersed main and control circuit contacts and vapor-proof overload relays. The entire unit is of compact design requiring little mounting space and is of dust-tight construction. It can be mounted out in the plant alongside the motor it controls and provides a vapor-proof, dust-tight and shock-proof installation.

Two thermal-type overload relays are used to protect the motors against single phase and overload conditions. The starters are tested and shipped with overload relays set to trip at 125 per cent of full-load motor current. When desired, however, this setting may be changed to any value between 100 and 150 per cent by turning a small knob on the outside of the relay cover. The new starter may be used for low-voltage release or low-voltage protection applications. Standard, vapor-proof, or explosion-proof push buttons are available for use with these starters.

Type ZO motor starter



Speed reducer for horizontal and vertical drives

Two-Speed Worm Gear Reducer

A TWO-SPEED worm gear reduction unit, designed for either horizontal or vertical drives of $\frac{1}{8}$ hp. and up where two speeds are required, has been introduced recently by Gears & Forgings, Inc., Cleveland, Ohio. This type of speed reducer is manufactured integral with motor or as a separate reduction unit, in speed reduction ratios ranging from 4:1 to 150:1.

The unit consists of a worm and worm gear and a set of differential gears, the driving shafts and their roller bearings all inclosed in a cast housing. The two speeds are obtained by means of the differential gearing. The high speed is obtained by moving the small hand lever to the right. This locks the differential to the low-speed shaft, on which the worm gear and differential gearing rotate as one unit. Movement of the hand lever to the left locks the side gear of the differential, preventing its rotation. Thus one-half of the revolutions of the worm gear are imparted to the slow-speed shaft. Change of output speed can be made while the unit is in operation under full load.

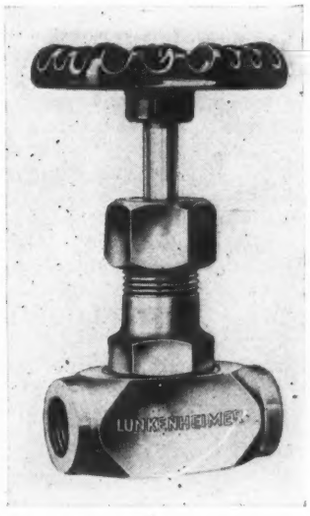
Improved Electrode for Mild Steel

FOR WELDING within the shielded arc on mild steel the Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio, has introduced an improved, heavily coated electrode. Like its predecessor, it is to be known commercially as "Fleetweld." The new electrode, as compared with the old, insures a higher ductility of weld metal, increased tensile strength and greater resistance to corrosion. It requires high welding current and allows welding speeds 2 to 4 times greater than those secured by bare or lightly coated electrodes. It is being produced in diameters from $\frac{1}{8}$ to $\frac{3}{8}$ in. and in two lengths, the standard 14-inch and the special 18-inch.

Steel Needle Valves for High Pressure

TWO LINES of steel needle valves designed for gas or liquid services in pressures up to 3,000 lb. at 150 deg. are now being offered by the Lunkenheimer Company, Cincinnati, Ohio.

The valves are identical in design, with steel body, hub, stem, stuffing box and gland. One line has a bar-steel body and is parkerized, and the other has a stainless steel body and is intended for use where corrosive fumes are present in the atmosphere. Both patterns are made in $\frac{1}{8}$-, $\frac{1}{4}$-, $\frac{3}{8}$- and $\frac{1}{2}$-in. sizes.



Stainless steel valve for pressures up to 3,000 pounds

NEWS of the FIELD

Commission Recommends Leasing Property At Muscle Shoals for Fertilizer Production

AFTER CAREFULLY CONSIDERING various proposals for the utilization of the Muscle Shoals project, the special commission appointed by the President and the state legislatures of Tennessee and Alabama has reported that it believes a contract for the leasing of the property can be negotiated readily if Congress passes enabling legislation. Such enabling legislation would involve the passage of an act empowering the President or an agency designated by him to negotiate a contract. The President has announced his intention of transmitting the report to Congress at an appropriate time.

In the opinion of the commission, the primary function of the Muscle Shoals property should be for the quantity production of fertilizer. Power would become of secondary importance and should only be sold when surplus amounts are available, the commission believes. In the sale of surplus power it is recommended that preference be shown to states, counties, and municipalities. After these public bodies have been permitted to contract for as much power as they may desire, it is proposed that chemical operations be accorded the next preference. The members of the commission unanimously agreed to the recommendations and conclusions.

Shortly after it was created, the commission made an attempt to ascertain the terms under which industrial organizations or farm associations would be interested in leasing the property. Although eight tentative bids were obtained, not one of these was deemed to be sufficiently satisfactory to warrant indorsement. Among its recommendations the commission has included a proposal for the up-river development of the Tennessee River. This involves the construction of the Cove Creek reservoir and an equalization dam below Wilson Dam. Preference as a lessee should be accorded a corporation exclusively owned and controlled by organizations of farmers, operated without profit, the commission believes.

Accompanying the report of the commission, the President received a report made by Col. M. C. Tyler, of the Corps of Engineers, dealing with costs that would be involved in transmitting and selling Muscle Shoals power. In his conclusions, Colonel Tyler states that the government's power plants at Muscle Shoals and the proposed Cove Creek development are not suitably located to serve as the main generating stations of an extensive independent power system. That the construction of an independent system would involve large expenditures of public funds. That the cost of transmitting power in such a system would be high and reliability of service at long distances from the generating center would be poor. That the construction of such an independent system would be an economic waste in that it would duplicate transmission facilities now ample to serve the region. That it may be expected that the deficit from the construction and operation of such a system, which would have to be met by the federal treasury and by the general taxpayers, will largely exceed any savings from lower rates which may accrue to the limited local public served."

Complete 213-Mile Gas Line For Long Beach Station

CONSTRUCTION of a 26-in. high-pressure natural gas pipe line, extending 213 miles from the Kettleman Hills oil fields in Kern County, Calif., to Long Beach, has been completed. The line, built for the Southern Fuel Company, which is owned jointly by the Southern California Gas Company and the Southern California Edison Company interests, was built in seven months at a cost of approximately $6,500,000. Capacity of the line is approximately 130,000,000 cu.ft. of gas a day, and this capacity can be increased to approximately 200,000,000 by the installation of compressor plants along the line.

The major requirements of the Southern California Edison Company's steam-electric generating station at Long Beach will be met through this pipe line. The Edison company uses approximately 90,000,000 cu.ft. of nat-

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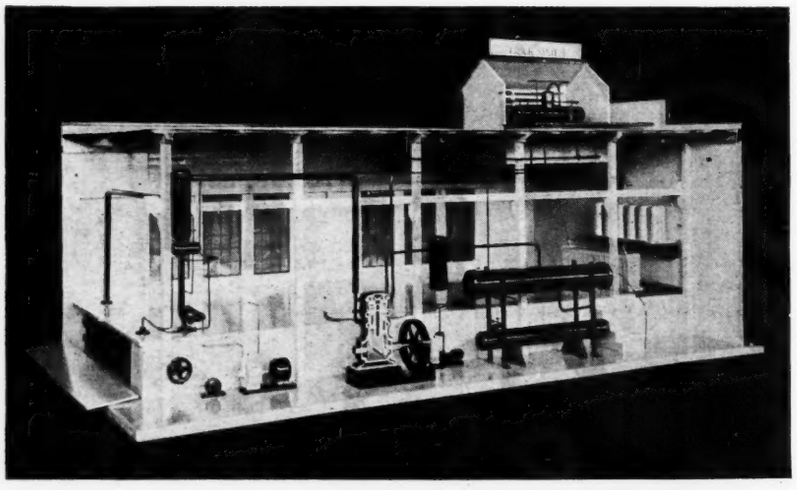
MODEL REFRIGERATOR PLANT



THE RAPID ADVANCE in the application of dual pressures in the refrigerator plant and the lesser information possessed by the operating engineer on dual pressure compared to that on single pressure refrigerator plants prompted the Frick Company, Waynesboro, Pa., to construct the model dual-pressure plant, which was shown at the convention of the National Association of Practical Refrigerating Engineers at Houston, Tex., last month. The model measures 70 in. long by 40 in. wide by 34 in. high, and accurately reproduces the latest type of group-lift plant. A hinged panel at the end of the tank discloses a minature vertiflow unit evaporator; at the opposite end of the tank appears a can filler of the measuring pressure type. A little crank on the end of the crane allows the grid of twelve cans to be dumped. The condenser shown above the ammonia receiver is of the horizontal multipass type. A float valve mounted just below the accumulator, an agitator, low-pressure air blower, and core-pumping set complete the standard ice making equipment.

The water and liquid ammonia precooling apparatus is shown in the penthouse on the roof.

ural gas daily in the generation of electric energy by steam power in the three plants of its Long Beach station on Terminal Island. Heretofore the gas supplied to the steam station has been delivered from southern California fields.

New Diesel Courses Started In Middle and Far West

FIRST TO ESTABLISH a school of diesel engineering in Portland, Ore., the L. L. Adcox Trade School has recently commenced offering four courses in the theory and practice of diesel-engine operation. Two courses in the practical operation, overhauling, rebuilding and repairing of different types of engines and two courses in the theory of diesel engineering are offered. The increased use of diesel power in a variety of applications and the opportunities for trained men created by this increase is given as the reason for adding the diesel engineering division to the school's original courses in auto and gas engines and in aviation mechanics.

The introduction this winter of a 23-week advanced course in internal-combustion engines by the Michigan College of Mining and Technology, Houghton, Mich., has received official faculty approval. This course, which brings the total of courses presented by the mechanical engineering department up to 26, covers internal combustion engines in the field of the heavy industrial diesel, the stationary gasoline engine, and marine and aircraft engines. The laboratory work will consist of engine design computations and of experiments on performance or development testing. Assistant Professor H. W. Risteen, formerly of the Comet Engine Corporation, is in charge of the course.

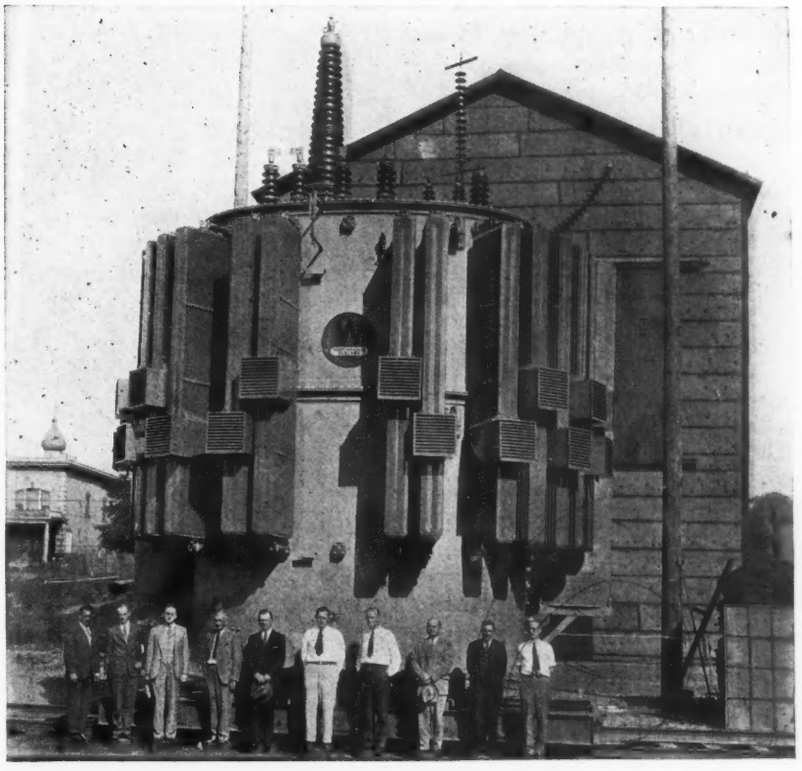
Lynchburg Hydro Plant Rebuilt and Enlarged

AT JUDITH DAM on the James River, about four miles above Lynchburg, the Appalachian Electric Power Company is just completing one of the largest hydro-electric plants in Virginia. The old power plant, which dates from 1903, has been reconstructed and modernized at an expenditure of approximately $1,250,000. While the original foundations were used, the present plant bears no resemblance to the old one, and the capacity has been increased from 6,000 to 16,750 horsepower.

The new installation consists of five 2,500-kw., 4,000-volt generators, each driven by a 60-in. water wheel. Two of these units were placed on the same foundation that has been used for two 1,000-kw. units installed in 1925. Due to a new type of so-called umbrella construction, they occupy very little more space than the smaller generators did. The other three units are located directly upstream from the 1903 building, an extension to which was constructed over the old water-wheel pits.

An interesting feature of this development is that the top of the new pond level is maintained at practically a constant height regardless of the flow of the river. To accomplish this the crest of the old dam was cut down 5 ft. and eight motor-operated steel gates were placed on top of the new crest. Weighing 40 tons, each gate is suspended by cables from a steel bridge supported by large concrete piers, and is operated by a 20-hp. elevator motor. The gates can be so operated that they will pass all the water in James River, even in flood periods, without raising the normal pool level.

LIGHTNING-PROOF TRANSFORMERS



One of the first 42,000-kva. transformers of a new lightning-proof construction, built by the Westinghouse Electric & Manufacturing Company for installation at the Baltimore end of the new transmission line from the Safe Harbor hydro-electric station. Tests made with a 3,500,000-volt generator proved that these transformers would stand severe surges incident to lightning striking the transmission line close to the transformers

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Not a Brooklyn Edison Plant

IN THE CAPTION to the picture on page 724 of the Nov. 17 number, showing a 24-year-old generator rotor which had been returned to the Westinghouse factory for rewinding, it was stated that the rotor had been running in the "Williamsburg power plant of the Brooklyn Edison Company." This should have been the Williamsburg power plant of the Brooklyn-Manhattan Transit Corporation.

Columbia Classes Opened To Unemployed Engineers

CLASSES in the Engineering School of Columbia University have been opened to unemployed professional engineers, Dean Joseph W. Barker announced last week. President Nicholas Murray Butler sanctioned the measure, Dean Barker explained, after the proposal had been advanced by the Professional Engineers' Committee on Unemployment and the Gibson Committee.

Applicants must secure a certificate from the engineers' committee, of which H. de B. Parsons is chairman, showing that they are accredited members of the profession and that they are idle through no fault of their own. They will present these credentials to Dean Barker who will assist them in arranging their class attendance. The number of the engineers admitted will be limited only by the size of the lecture halls.

Catalogs and class schedules have been sent to the committee, which has its headquarters in the Engineering Societies' Building, New York City.

"The principal purpose for opening the classes without fee or credit to the engineers," Dean Barker said, "is to preserve the morale of these skilled men during a period of enforced idleness."

News of Canada

New tidal power plan for Nova Scotia; 300,000-hp. project on Ottawa River; Saskatchewan considers 125,000-hp. development

A NEW SCHEME for developing power on the Chignecto Canal was outlined recently by Harold S. Johnston, chief engineer of the Nova Scotia Power Commission. A modified single-basin tidal hydro-electric power development is proposed. The basin will be the tidal estuary formed by the confluence of the Maccan River and River Hebert, southwest of the town of Amherst. A dam across the mouth of this estuary near the head of Minudie Marsh will create a basin with an area of 8 sq.mi. The tide at this point has a range of 45 ft. at spring and 38 ft. at neap tides. It is proposed to fill this basin at high tide, and when the tide is down use the water from this basin to a depth of about 6 ft., under a varying head, through Kaplan turbines to generate electric energy.

Part of this energy will be used to produce steam in electric boilers, which will be stored in Ruths accumulators, for use in steam turbine-electric units, when energy is not available directly from the water-driven units, through lack of sufficient head. Under the proposal outlined, at the extreme neap tides occurring very occasionally in the course of a year, a continuous production of 40,000 electric hp. may be counted upon as primary energy.

A NEW PROPOSAL for a large hydro-electric project on the Saskatchewan River, near Fort a la Corne, is being considered by the Saskatchewan Government. According to the engineers, the project could be constructed for a total cost of $12,207,135 and would generate 125,000 hp. The engineers state that the project is physically and economically feasible, and more particularly as a public enterprise. The proposed power site, 2½ miles below Fort a la Corne, is approximately 40 miles east of Prince Albert, 110 miles from Saskatoon, and 190 miles from Regina. These three cities together with Moose Jaw will enter largely into the proposals for transmission lines and the marketing of the power.

EXTENSIVE POWER DEVELOPMENT on the Ottawa River for a distance of 80 miles, from the dam at Temiskaming as far as Allumette Lake, by the Gatineau Power Company, within the next two years is heralded in a recent order-in-council passed by the Quebec Government, which is subject to the ratification of an agreement between the Province of Quebec, the Ontario Hydro Electric Power Commission, the Federal Government and the Gatineau Power Company.

The order-in-council authorizes the Minister of Lands and Forests to accord to the Gatineau company control of the Ottawa River within the Province of Quebec, under certain conditions. They consist of the reconstruction of the dam at Temiskaming by the power company with the consent of the Federal Government, if the latter does not decide to undertake the work itself; the preservation of the present flow of the river to owners of existing lease holders on the river below the points mentioned, and certain rights to be accorded to the Ontario commission.

Allumette Lake is the widening of the Ottawa River, at the town of Pembroke, Ont. There are numerous rapids between the upper end of the lake above Pembroke and the lower end of Lake Temiskaming, the power potentialities being understood to total 300,000 hp. or more.

No Slump Reported in Natural Gas Business

DESPITE the general business slump, the natural gas industry is forging steadily ahead in a program of rapid expansion. It is esitmated that a record-breaking mileage of pipe-line construction will be completed this year, on which over $250,000,000 will be spent for pipe alone, according to John J. Bergen, authority on natural gas securities, speaking recently in New York City. "Close to 50,000 gas wells, draining a land area of 15,000,000 acres, are now supplying an estimated market of 16,000,000 persons and 8,000 large industrial plants," said Mr. Bergen. "The 2,000,000,000,000 cu.ft. of natural gas used in the United States last year represents an energy value six times as great as that of all generated electric power in the country. The natural gas output is three times that of manufactured gas."

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COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association, Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

Seventh Annual Conference on Welding, to be held by the Engineering Extension Department of Purdue University at Lafayette, Ind., Dec. 10-11. Professor in charge, W. A. Knapp, Engineering Extension Department, Purdue University, Lafayette, Ind.

Taylor Society to Discuss Business Stabilization

ECONOMISTS, bankers, government officials and business and industrial leaders will discuss the causes of the present world depression with the view of offering recommendations for the stabilization of business and industry through scientific planning, at the annual fall meeting of the Taylor Society in the Hotel Pennsylvania, New York City, Dec. 2 to 4, inclusive.

One session of the meeting will be devoted to the topic "Power and Mechanization as Causes of Depression." At this session, to be held on Dec. 3 at 2:30 p.m., the speakers will be George Soule, economist and an editor of *The New Republic;* Hudson Bridge Hastings, professor of industrial engineering at Yale University; Milton C. Herrmann of New York; and Edward F. Harvey of Philadelphia. A recently published English book, not yet generally known in the United States—Fred Henderson's "The Economic Consequences of Power Production"—will be used as the point of departure for this discussion.

Commission Calls Hearing On Current River Projects

THE FEDERAL POWER COMMISSION has voted to hold a public hearing Jan. 5 on the conflicting applications of Doniphan Hydro Electric Company, of Doniphan, Mo., and Current River Power Company, of Kansas City, Mo., for preliminary permits for power projects on Current River above Doniphan, it was announced Nov. 23.

The application of Doniphan company was filed in final form on Feb. 25, and contemplates one dam, with power plant adjacent thereto, at Gartman Rock about one mile above the town of Doniphan. The dam would be 107 ft. high, creating a head of about 103 ft. The pool from this dam would extend upstream for a distance of about 34 mi., the head of the pool being a few miles downstream from Van Buren.

The application of Current River Power Company, filed Aug. 10, contemplates the construction of three dams across Current River, with a power plant at each. These dams would be located at Hargus Eddy, 6½ mi. upstream from Doniphan; below the mouth of Mill Creek about 43 mi. above Doniphan; and below the mouth of Blairs Creek about 67 mi. above Doniphan.

The Hargus Eddy project is in conflict with the proposed Gartman Rock development. Hargus Eddy is about 3 mi. upstream from Gartman Rock, but the proposed pool levels are at the same elevation, and therefore the backwater effect would extend to the same point upstream. The fall between Hargus Eddy and Gartman Rock is about 23 ft. Either development would have an installed capacity of approximately 50,000 horsepower.

Personals

G. H. HARRIES, major-general, U. S. A., retired, and formerly vice-president of H. M. Byllesby & Company, Chicago, has retired from the active engineering field in which he was an outstanding figure for a number of years. General Harries in the course of his career has been treasurer of the National Electric Light Association and president of the Association of Edison Illuminating Companies, the American Electric Railway Association and the Illuminating Engineering Society. He has established residence in Los Angeles, Calif.

HARRY SLOAN, advisory engineer for the Vilter Manufacturing Company, has been elected president of the Engineers' Society of Milwaukee for the coming year. FRASER JEFFREY, electrical engineer with the Allis-Chalmers Manufacturing Company, was elected vice-president, and WATLER R. MUELLER and HUGO W. ROHDE were re-elected treasurer and secretary, respectively. The new directors, elected for three years, are FORREST NAGLER, mechanical engineer with the A. O. Smith Corporation; JAMES BROWER, superintendent of the Milwaukee Sewerage Commission; and GEORGE G. POST, vice-president and chief electrical engineer of the Milwaukee Electric Railway & Light Company.

W. HANE, formerly in charge of the Jefferson City (Mo.) plant of the Missouri Power & Light Company, has assumed new duties as chief engineer of the company's plant in Mexico, Mo. T. E. HOBBS, assistant superintendent at Jefferson City, has been promoted to chief engineer at that plant.

PANFILO TROMBETTA has resigned from the research laboratory of the A. O. Smith Corporation, Milwaukee, to organize the Solenoid Company, which will manufacture special direct- and alternating-current electromagnets, motor controllers and thermal overload protective devices.

A. W. MANBY, who was chief operator of the Queenston generating station of the Hydro Electric Power Commission of Ontario, at Niagara Falls, has been transferred to the commision's new Chats Falls plant at Fitzroy Harbour, Ont.

W. M. YOUNG, of the electrical engineering department at the University of Iowa, Iowa City, has joined the engineering research department of the Taylor Instrument Company, Rochester, N. Y.

ARTHUR M. TODE, formerly in charge of the marine department of the Texas Oil Company in New York City, has opened offices as consulting marine engineer in Suite 1011, 17 Battery Pl., New York, N. Y.

How's Business?

MOST measures of industrial and trade activity indicate nothing more than stabilization at prevailing low levels as business prepares to dig in for the winter and watch the coming congressional carnival of political winter-sports in Washington. Steel and motors appear most hopeful of keeping some of the home fires burning in anticipation of Spring improvement, and there is no doubt that sentimental expectation of a fresh start after the turn of the year has strengthened in many lines of business. There is nothing demonstrably unreasonable in this, despite the obvious obstacles to be overcome, or the apparently unanswerable economic oracles who can always prove by precedent that everything that happens is impossible.

—*The Business Week*, Dec. 2.

Business Notes

FAIRBANKS, MORSE & COMPANY, Chicago, Ill., announces that A. W. Thompson, who for the past five years has been Pacific Coast manager in charge of sales, has been appointed vice-president in charge of manufacturing. Mr. Thompson joined the Fairbanks-Morse organization in 1920 as general manager of the Indianapolis plant. Prior to that he had been associated with the General Electric Company for ten years, during which time he was in charge of the development of the Erie works of that company.

I-T-E CIRCUIT BREAKER COMPANY, Philadelphia, Pa., announces that it will donate 2 per cent of its gross sales for November, December, January, February and March to President Hoover's Committee on Unemployment Relief. No order for less than $50 will be included in the plan, the company states, and contributions will be paid within ten days after the receipt of each order from a special $25,000 fund deposited for the purpose in a Philadelphia bank.

FOSTER WHEELER CORPORATION, New York, N. Y., announces the opening of a branch office at 726 Jackson Pl., N.W., Washington, D. C. J. S. Malseed, formerly of the New York office, will be in charge of the new branch.

ALLEN-BRADLEY COMPANY, Milwaukee, Wis., announces that Eugene F. LeNoir, formerly president and general sales manager of the Union Electric Manufacturing Company, of Milwaukee, has been appointed a special representative of the company. Mr. LeNoir, who has had extensive experience in the motor-control field, will in his new capacity contact with motor manufacturers through the Allen-Bradley district offices and agents.

HOMESTEAD VALVE MANUFACTURING COMPANY, Coraopolis, Pa., announces the appointment of Chatard & Norris, 218 Water St., Baltimore, Md., as its exclusive representatives in the eastern part of Maryland and the District of Columbia.

AIR PREHEATER CORPORATION, Wellsville, N. Y., announces that it is now represented in Washington, D. C., by Irving M. Day, with offices in 306 Chandler Building.

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Trade Catalogs

PUMPS, EJECTORS, COMPRESSORS — Worthington Pump & Machinery Corporation, Harrison, N. J., has just issued the following specification sheets: WD-310-B3 on centrifugal pumps, groups, C, D, L, R and U, and pumps for sumps, irrigation and drainage; D-412-B1, D-412-S5, D-412-S6 and D-423-E10 on power pumps; DW-110-B1 on steam pumps; W-205-S1A and W-205-S2 on single and double-unit two-stage steam-air ejectors; and L-621-B3 on vertical and horizontal feather-valve air compressors.

TEMPERATURE CONTROLLERS — Two new bulletins on temperature controllers have just been issued by The Bristol Company, Waterbury, Conn. Catalog No. 2050 illustrates and describes pyrometer controllers for temperatures up to 3,000 deg. F. Catalog No. 2025 covers the principal features of thermometer controllers with temperature ranges from —30 to +1,000 deg. F.

FEED WATER TREATMENT—A new illustrated bulletin describing the Neckar process of feed water treatment, which features recirculation and automatic blow-down, has just been issued by The Neckar Company, 67 Wall St., New York, N. Y.

CAPACITORS, SPEED REDUCERS—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued two new bulletins as follows: 20044-F covering group-type capacitors for 60-cycle power-factor correction on loads smaller than synchronous condensers will handle economically; and L.20520 on Westinghouse-Wise multi-speed drives for motors ranging from ½ to 15 horsepower.

VALVES, CONTROLLERS — The flow characteristics and construction of Fisher valves are described and illustrated in Circular No. 830 just issued by the Fisher Governor Company, Marshalltown, Ia. Other new publications of the company include Bulletin No. 70 on "Series 4000" auxiliary-actuated pressure controllers and Circular No. 835 on liquid-level controllers.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Benton—Farm Colony, State Hospital for Nervous Diseases, c/o Arkansas Construction Commission, T. Davis, Secy., 207 Marion Hotel, awarded contract for construction of a boiler house to William Peterson, Donaghey Bldg., Little Rock, chimney to Rust Engineering Co., Woodward Bldg., Birmingham, Ala. Action on waterlines, boilers, etc., deferred.

Conn., Meriden—Connecticut Light & Power Co., 39 West Main St., Meriden and 155 High St., Hartford, awarded contract for a 1 and 2 story, 25 x 100 and 80 x 150 ft. service building on Cooper St. to Hayes Construction Co., 1285 East St., New Britain. Estimated cost $140,000.

Conn., South Manchester — Folly Brook Ice Co., Leland T. Wood, 51 Bissell St., having plans prepared for construction of a 1 story, 62 x 125 ft. ice plant at Bissell St. and Johnson Terrace. Estimated cost $75,000. Private plans.

Ill., Bloomington—City, Herman Bock, Clk., will soon award contract for waterworks improvements, including replacement of boilers, pumps, oil engines and generators. Estimated cost $117,000. Taylor-Woltman, Unity Bldg., Bloomington, are engineers.

Ill., Colchester—City plans waterworks improvements including well, pump house, centrifugal pumps, storage tank, etc. Estimated cost $70,000. W. A. Fuller Engineering Co., 2916 Shenandoah Ave., St. Louis, Mo., is engineer.

Ia., Glidden—Town Council, defeated bond election of November 4 for construction of a municipal light and power plant including two 150 hp. Diesel engines direct connected to 100 kva, 3 ph., 60 cycle, 2,300 v. generators with exciters, auxiliary equipment, etc. Hennington Engineering Co., 326-30 Union State Bank Bldg., Omaha, Engr.

Ia., Villisca—City plans an election December 7 to vote $150,000 bonds for construction of a municipal light and power plant.

Ia., Walnut—City awarded contract for a 275 to 375 hp. vertical multi-cylinder Diesel engine generator unit, exhaust stack, motor driven air compressor, auxiliary fuel tank, motor driven pumping unit, six panel switchboard, etc., in connection with proposed improvements to municipal light and power plant to Fairbanks-Morse & Co., 9th and Harney Sts., Omaha, Neb. $27,985.

Mass., Gloucester—Gloucester Fish Pier Corp., J. A. Dahlmer, having preliminary surveys made for construction of a warehouse and refrigeration plant at Gloucester Fish Pier. Estimated cost $50,000. Fay, Spofford & Thorndike, 44 School St., Boston, are engineers.

Mass., Roxbury (Boston P. O.)—New England Deaconess Hospital, H. Brewer, Pres., plans construction of a heating plant at hospital on Deaconess Road here. Estimated cost $75,000. Engineer not selected.

Minn., Duluth—Minnesota Power & Light Co., W. H. Burke, Pres., 30 West Superior St., plans construction of second unit to steam generating plant on Main St.; also installation of equipment to generate 35,000 hp. Estimated cost $3,000,000.

Miss., Starkville—City, T. J. Gladney, Clk., will receive bids until December 11, for construction of electric light plant and distribution system. Estimated cost $100,000.

Mo., Everton — City plans an election in spring to vote $20,000 bonds for waterworks improvements including deep well, pumps, tank on tower, distribution mains, etc. Western Engineering Co., Olive and Robberson Sts., Springfield, is engineer.

Mo., St. Louis—Forest Park Highland Exhibition & Amusement Co., 5600 Oakland Ave., awarded contract for refrigeration equipment to be installed in indoor ice skating rink at 5700 Oakland Ave. to Sterling Ice Machine Co., Springfield. Estimated cost $50,000.

N. J., Irvington—Public Service Electric & Gas Co., Terminal Bldg., Newark, awarded general contract for construction of a 2 story, 40 x 110 ft. electric sub-station on Springfield Ave. here, to United Engineers & Constructors Inc., 80 Park Pl., Newark. Estimated cost $115,000.

N. J., Jersey City—St. Peters College, J. S. Dineen, Pres., 144 Grand Ave., is having sketches made for construction of a 10 story college building, including steam heating system, etc., at Lincoln Park and Gifford Ave. Estimated cost $750,000. Architect withheld.

N. J., Manasquan—Block Ice & Cold Storage Co., Toms River, plans to rebuild ice plant destroyed by fire here. Estimated cost $40,000. Architect not selected.

N. J., Trenton — State House Commission, awarded contract for construction of a new heating plant at Trenton Armory to Burns, Lane-Richardson, Adams Ave. $39,887.

New York—Lamoka Power Corp., c/o G. R. Mills, Sodus, plans construction of power plant at Lake Keuka in vicinity of Elmira. Estimated cost $1,000,000.

N. Y., Long Island City—Save Service Station Inc., 852 Jamaica Ave., Jamaica, plans construction of a 1 story, 73 x 148 ft. ice manufacturing plant at Platewood Ave. and Long Island R.R. tracks. Estimated cost $45,000. Private plans.

N. Y., Millport—Keystone Gas Co. Inc., plans construction of a gas plant in Chemung County.

N. Y., New York—Dept. of Water Supply, Gas & Electricity, Municipal Bldg., will receive bids in May or later for construction of waterworks pumping plant and equipment on Rondout Creek. Estimate cost $800,000.

O., Cleveland—City, G. B. Sowers, Comr. of Engineering & Construction, will start plans soon and take bids in summer 1932 for construction of power house and administration building at Easterly Sewage Treatment Plant. George B. Gascoigne, Leader Bldg., is engineer.

Okla., Durant — City plans an election December 8 for rebuilding waterworks plant and add new pumping equipment. Estimated cost $15,000. L. V. Stinson, Durant, is engineer.

Okla., McAlester—Board of Affairs, Capitol, Oklahoma City, awarded contract for a 1,000 hp. turbo generator set for State Penitentiary to Cook & McDonald, 627½ West Second St. $64,000.

Pa., Meadville—City, G. S. Maxwell, Clk., awarded contract for construction of a sewage disposal plant, including pumping station, mains, etc., to Keystone Construction Co., Race St., Meadville, $123,347.

S. D., Aberdeen—City, c/o Lydia Kohlhoff, Auditor, plans construction of a municipal power plant and distribution system. Bemis Co., 332 South Michigan Ave., Chicago, Ill., is engineer.

Tex., Dallas—City, c/o E. Goforth, Secy., voted $1,000,000 bonds and will receive bids in 1932 for construction of a sewage disposal plant including 44 x 74 ft. pump and blower station, 20 x 20 ft. pumping station, 34 x 54 ft. screen houses, six air compressors, etc. Hawley, Freese & Nichols, Capps Bldg., Fort Worth, are engineers.

Utah, Fairview — City voted $30,000 bonds for waterworks improvements and hydro-electric improvements.

Wis., Appleton—Lutz Ice Co., O. Lutz, Pres., 109 North Morrison St., plans construction of a 2 story, 85 x 150 ft. ice manufacturing plant to include equipment. Estimated cost $40,000. Architect not selected.

Que., Hull—Gatineau Power Co. Ltd., C. G. Gale, Mgr., will soon receive bids for construction of several power units on Ottawa River between dam at Timiskaing and Lac Allumette. Estimated cost $5,000,000.

Equipment Wanted

Air Compressor—Hartford, Conn.—Board of Contract & Supply, Richard Dillon, Clk., will receive bids until December 7 for Cont. 8, portable air compressor for Water Bureau, Union St. Yard.

Engine—Manilla, Ia.—City Council, R. W. Barber, Clk., will receive bids until December 7 for multi-cylinder, 4 cycle, air injection Diesel oil engine.

Operating Machinery—Harvey, La.—U. S. Engineer, Poland and Dauphine Sts., New Orleans, will receive bids until December 15 for furnishing, setting and erecting fixed irons, gates and operating machinery for locks, Louisiana and Texas Intercoastal Waterway here.

Pump, Motor, Est.—Palmer, Mass.—S. C. S. Box Co., plans to purchase a pump and motor 110 v., and vented receiver with float switch for returning condensation to boiler about 4,000 ft. radiation, also two steel smokestacks.

Boiler and Stoker — East Lansing, Mich. — Michigan State College, H. H. Holladay, Secy., will receive bids until December 10 for furnishing and installing a 1,000 hp. boiler with boiler setting and stoker for power plant at Michigan State College.

Transformer—Brooklyn, N. Y.—Signal Supply Officer, Army Base, 58th St. and First Ave., will receive bids until December 4 for fifty transformers, S. C. type C-74.

Compressor — Memphis, Tenn. — Blumenfeld Ice & Coal Co., 1441 Lamor St., plans to purchase ammonia compressor Frick or York type.

Boiler—Westminster, Vt.—W. L. Mayor, plans to purchase a 50 hp. 100 lb. horizontal boiler, etc.

Industrial Projects

Ind., Mishawaka—A. Johnson Forge & Machine Co., 1015 East Madison St., South Bend, awarded contract for construction of a 1 story, 60 x 100 ft. factory east of Mishawaka to C. Van-Den Borre, 319 South Center St., Mishawaka. Estimated cost $40,000.

Mass., Canton — Draper Bros. Co., Draper Lane, is receiving bids for construction of a power house. Estimated cost $40,000. Private plans.

Mass., Lynn—North Shore Cutting Die Co., 898 Broad St., awarded contract for a 1 story factory addition to J. Broasky, 59 Callender St., Dorchester. Estimated cost $40,000.

Minn., Cloquet—Berst-Forster-Dixfield Co., H. Dickman, Mgr., awarded contract for construction of a 3 story, 106 x 274 ft. factory for the manufacture of pulpwood dishes and other wood specialties, to James Leck Co., 211 South 11th St., Minneapolis.

N. Y., New York—Superior Fireproof Door & Sash Co., 1811 Carter Ave., will build a 2 story, 50 x 100 ft. factory at Barnard and Barbour Sts. Estimated cost $40,000. H. Ginsberg, 205 East 42nd St., is architect. Work will be done by day labor and separate contracts. Maturity early spring.

O., Fostoria—Electric Auto-Lite Co., awarded contract for installation of two 175 hp. mechanical atomizing oil burners in 150 hp. boilers, also provision for 25,000 gal. oil storage and extension to present stack, to Howard C. Bakery Co., 128 South St. Clair St., Toledo.

Tex., Baird—Octane Oil Refining Co., will build an oil refinery, 1,500 bbl. of crude oil daily capacity. Estimated cost $250,000. Private plans. Most of work will be done by day labor.

Tex., Corpus Christi—Southern Alkali Corp., subsidiary of Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa. and American Cyanamid Co., 535 5th Ave., New York, will soon award contracts for construction of chemical plant on 389 acre site near turning basin here. Estimated cost approximately $10,000,000. Contractors and dealers get in touch with owners.

Tex., Rio Grande—Rio Grand City Oil Co., plans construction of refinery plant. Estimated cost $175,000. Private plans.

Va., Alexandria — Ford Motor Co., 3674 Schafer Road, Dearborn, Mich., acquired a site and plans construction of an assembly plant on Potomac River here.

B. C., Vancouver—Vancouver Malt & Sake Brewing Co. Ltd., 2235 Triumph St., awarded contract for construction of a new malt factory to consist of warehouse, bottling and shipping room, storage room, boiler rooms, etc., at 1445 Powell St.

Ont., Amherstburg—Simrall Refining Corp., Union Central Life Bldg., Cincinnati, O., is receiving bids for construction of a petroleum refinery, 2,500 bbl. daily capacity here.

POWER

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ELY C. HUTCHINSON, *Editor*

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Killing the Goose

There is, of course, plenty to say about the ethical relations between buyer and seller. But how do the sellers get along among themselves?

It cannot be held against the buyer when sellers—not all but some—steadfastly set out with the intention of taking this or that order or putting this or that competitor out of business. There are many ways to hand the buyer a better price than he ever expected and at times a lower figure than he is perfectly willing to pay.

One of these is for a bidder, when suspecting a competitor's goods to be preferred for some reason peculiar to a certain job, deliberately puts in a price below commercial cost. The culprit thereby hopes to embarrass the buyer and through him force the competitor to accept an unprofitable price for his equipment.

While the buyer may and frequently does deplore these tactics, he does not always have the courage to resist this unethical selling procedure. So when it is all over the buyer has the equipment he wanted, at a price lower than he was willing to pay. The legitimate recipient of the order gets it at an unprofitable price and the unethical competitor chortles with ill-concealed glee at what he thinks a smart trick.

If he thought twice he would realize that he has only succeeded in harming himself, for he has wilfully contributed to the destruction of future profit from his own sales.

EDITORIALS

Coal Silos For Central Stations

The silo originated on the farm for the storage of cut fodder. Later it was used by domestic coal dealers to store coal in their yards, and to some extent by railroads. More recently it has been applied to central stations, and its use has aroused some discussion.

It is claimed for the concrete silo that it affords the cheapest means for storing coal where land is not at a premium. The silos are placed outside the boiler room, thus permitting the latter to be well lighted and ventilated. The absence of a heavy overhead coal bunker admits of lighter foundations and steelwork in the boiler room and so reduces building cost.

In considering the general use of silos several conditions must be kept in mind. All coals do not possess the same characteristics. Some tend to arch more than others. This tendency may be aggravated in a silo unless it be of large diameter. Also, where very low temperatures prevail in winter and coal arrives in a wet or snow-covered condition there is a tendency for the mass to freeze. Breaking up a frozen coal mass in a concrete soil would be troublesome.

While coal, if not frozen or arched, easily flows by gravity from a silo to pulverizers placed at a lower level, if stokers are used the silo must be carried to a greater height or an elevator must be provided to raise the coal to the stoker hopper.

Its low first cost, maintenance and operating expenses under ordinary conditions, together with the resulting well-lighted boiler room, commend the silo for central station service, and its use will undoubtedly extend.

Power will welcome further data on operating costs and experiences with this form of coal storage.

A Promising Use For Fly Ash

Coincident with progress in the recovery of fly ash from pulverized-coal furnaces, research has been directed toward finding suitable uses for such ash. While the number of possible applications is large, economic considerations dictate that the quantity required be large and that the usual difficulties in transportation be considered. Obviously, this narrows the field of application. Among the more promising uses heretofore indicated have been fertilizer filler, asphalt filler, road surfacing, cinder blocks, mold-dusting powder and, to a limited extent, paint filler.

Recent research at the chemical laboratory of Purdue University has developed what appears to be the most promising use thus far advanced, namely, the production of a hard-surface brick. This has met all the tests ordinarily prescribed for brick and present indications are that the cost of manufacture would not be greater, and possibly less, than that of brick made in the usual way. The process is entirely chemical, without baking, and no special machinery is required. Any desired color can be had by the addition of metallic oxides, which opens up a field for interior use. The brick cannot be used as a refractory, but would be adaptable to the outside of boiler settings and interior or exterior building walls.

The work at Purdue may be a key to the fly ash disposal problem. While the demand for dust abatement is being pushed in many localities, the expense involved in adequate dust recovery has impeded its wider application. A byproduct such as this brick would offset this expense and in many cases solve the problem of ash disposal.

Burning Cheaper Oil In Diesel Engines

Although supercharging is of vital importance in marine diesel engines where engine room space is at a premium, it seems the part of wisdom that American builders of stationary diesels should give more attention to fuel oil than to supercharging methods.

In exceptional cases an increase of 50 per cent in engine output is obtainable by the addition of supercharging equipment. But with this increase comes serious problems of heat distribution, not to mention cost of the additional blower equipment for scavenging. On the other hand, if by redesign of the oil-spraying mechanism and the combustion chamber, a combination of cracking-still and distillate oil, obtainable at nominally two cents a gallon, or for that matter, boiler oil, could be successfully handled in place of the present nominally four-cent distillate, fuel costs per horsepower would be halved at practically no additional manufacturing cost.

Diesel engines are selling around $75 a kilowatt. At 12 per cent, the yearly fixed charges per kilowatt capacity would be $9. If such an engine operates with a yearly fuel consumption per kilowatt of rating of four hundred gallons, a reduction of two cents a gallon would make a net saving of $8. This practically equals the capital charges. Thousands of engines are now burning five- or six-cent oil.

So for the time being the employment of superchargers does not hold out the advantages obtainable by redesign to permit use of cheap blended oils. To accomplish most in this direction it is hoped that more of the engine builders will actively support the work of the A.S.M.E. Fuel Oil Research Committee.

▼

POWER Stands for .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

A. S. M. E.

HOLDS 52d ANNUAL MEETING IN NEW YORK

More than 1,850 engineers, scientists, economists, educators and representatives of finance and industry attend sessions featuring a diverse array of technical and economic papers. Power discussions cover fuels, industrial power, boiler feed water, central station power, steam tables, lubrication, hydraulics and oil engines

Honorary membership was conferred on Dr. Calvin W. Rice, in recognition of his 25 years' service as secretary of the society

Dr. Palmer C. Ricketts, president of Rensselaer Polytechnic Institute, was awarded honorary membership for his contribution to engineering education

THAT the engineering profession is vitally interested in the economic and social problems of the present day was demonstrated by the extensive consideration given these subjects at the 52nd annual meeting of the American Society of Mechanical Engineers, held in New York City from Nov. 30 to Dec. 4. Besides a large and diverse array of papers presented at the 26 technical sessions, eleven of which were devoted to power subjects, there were many addresses and discussions bearing directly on the timely topics of unemployment relief, business stabilization and the correction of social evils.

A review of the nation-wide programs of the American Engineering Council for the relief of unemployment was given by L. W. Wallace, executive secretary of the council, at the business meeting on Tuesday afternoon. The emergency program, he said, was being carried forward with all possible speed by state committees of engineers through direct relief measures and the promotion of immediate public works projects. At the same time the council in cooperation with governmental and social agencies was working out the future program, which involved the attainment of security, the increase and constructive use of leisure, balancing public and private economic enterprises, and integrating agriculture and industry.

Following the report of the Committee on Economic Status of the Engineer (see *Power,* Sept. 1), given by Prof. Elliott Dunlap Smith of Yale University, President-Elect Conrad N. Lauer outlined the committee's program for upbuilding engineering as a profession. This includes joint action of the major engineering societies to guide youth in its consideration of an engineering career, to cooperate with educational institutions, to direct the after-college training and to certify the educational and professional attainments of engineers within the profession.

Other business of the meeting included the presentation of the council and committee reports for 1930-31 by Secretary Calvin W. Rice, a unanimous vote to continue the society's policy of accepting advertising in its publications, and the confirmation of the 1932 nominating committee as follows: R. E. Newcomb, Holyoke, Mass.; W. A. Shoudy, New York City; H. R. Cook, Jr., Baltimore, Md.; D. E. Kehoe, Savannah, Ga.; W. M. Taylor, Indianapolis, Ind.; Max Toltz, St. Paul, Minn.; and U. V. Hough, Spokane, Wash.

On Monday evening, previous to the business meeting, seven engineers participated in an extemporaneous public speaking contest, following which the Metropolitan Section orchestra played and the second exhibition of art by engineers was formally opened. The

latter comprised 76 works of painting and sculpture.

The fourth Henry R. Towne Lecture on the relation between engineering and economics was given on Tuesday afternoon by W. B. Donham, dean of the Graduate School of Business Administration at Harvard University, who discussed "The Temporary Emergency and Twenty-Year Planning."

Emphasizing the rapid tempo of changing conditions in the present machine age, Dean Donham drew an analogy from nature in the survival of the living organism under varying conditions of environment. Such survival, he said, had been accomplished through the evolution of unconscious, automatic methods of dealing with external variables; such as sweeping, permanent changes in modes of living, insulating and defense mechanisms, and compensating devices within the organism. He suggested that man might well adopt many of these methods in planning for economic stability.

Sickness, old age and death benefits through government insurance would effect a permanent change in our mode of living, he said, and reduce the insecurity of existence. Unemployment insurance was not included in this category because it had no actuarial basis and tended sooner or later to become a factor contributing to instability, in the form of a degrading dole. Unemployment, Dean Donham thought, could best be handled by compensating devices.

The tariff, army and navy, properly used, were the insulating and defense mechanisms needed for a secure national economy.

Under compensating devices, Dean Donham mentioned governmental planning and statistical organizations which would keep up-to-date data on business conditions and employment, prepare comprehensive public works programs and see that these programs were put into action whenever and wherever falling indices of business or employment indicated the need for them.

Conrad N. Lauer, president of the Philadelphia Gas Works, who was installed as president of the society

With these suggestions as to how a general plan might be worked out, Dean Donham offered four tests for any specific plan or remedy which may affect national and business policies for the next twenty years:

"First: Is the remedy or plan one which will apply to changing conditions? In other words, does the scheme suggested hold out hope of dealing successfully with changes of the types which are happening about us, and particularly with advances in science and management, or is it likely to hinder us in dealing with such changing conditions? Is the plan or mechanism suggested one which may itself be readily adapted to new conditions? We need, not to prevent the changes which constitute the basis for progress, but to secure compensating mechanisms which will prevent such changes from destroying our social organism.

"Second: Does the suggested plan or mechanism maintain, so far as may be consistent with the needs of our people generally, the maximum of opportunity for the individual? Such opportunity should be preserved notwithstanding the fact that individual opportunity carries with it a necessary accompaniment of individual risk.

"Third: The test of stability. Does the suggestion hold out hope that it will furnish or contribute to securing in a changing world the social stability which we must attain as an essential condition to continued progress?

"Fourth: What are its probable effects on our political structure? Does it minimize the strains on a democratic society?"

Roy V. Wright, retiring president, delivered the annual presidential address in the evening at the president's night ceremonies.

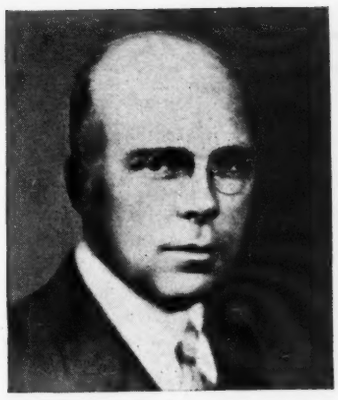
"The engineer," said Mr. Wright, "has been subjected to harsh and severe criticism in these recent years. While much of this may not have been deserved, it promises to be helpful to the profession—strange as it may seem—if for no other reason than that it is forcing the engineer more thoroughly and critically to examine his part in and contribution to our economic program and progress. Moreover, it is encouraging him, also, to develop a larger and s t r o n g e r professional consciousness. Again, it is a clear indication that certain elements, at least, are looking to him for leadership in helping to solve some of our more pressing economic problems.

"We need militant engineers —aggressive and constructive —who will enthusiastically devote their e n e r g i e s to building up the engineering profession, raising it to higher levels, and will vigorously take the offensive in helping to find a solution of some of the great economic problems which we are now facing."

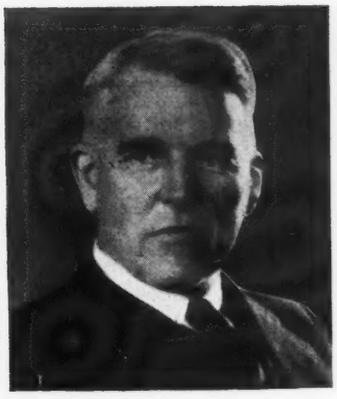
After Mr. Wright's address the following new officers were installed: President, Conrad N. Lauer, president of the Philadelphia Gas Works; vice-presidents—Robert M. Gates, vice-president of the Superheater Company, New York; William B. Gregory, professor of experimental engineering at Tulane University; Fred H. Dorner, sales engineering executive, Milwaukee; and Charles M. Allen, professor of hydraulic engineering at Worcester Polytechnic Institute; managers—Eugene W. O'Brien, editor of the *Southern Power Journal;* Harry R. Westcott, president of the Westcott & Mapes Company, New Haven; and Alexander J. Dickie, editor of the *Pacific Marine Review.*

Honorary membership in the society was conferred at this time on Dr. Palmer C. Ricketts, for 30 years president of Rensselaer Polytechnic Institute, "in recognition of his contributions to engineering education."

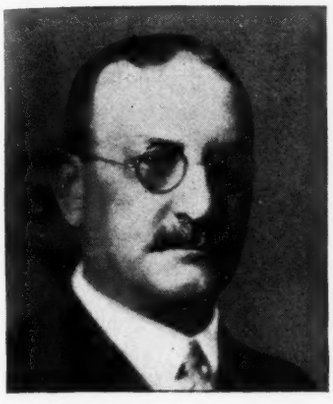
The A.S.M.E. Gold Medal was awarded to Albert



ROBERT M. GATES
Vice-President



CHARLES M. ALLEN
Vice-President



WILLIAM B. GREGORY
Vice-President

FRED H. DORNER
Vice-President

Kingsbury, president of the Kingsbury Machine Works, Inc., Philadelphia, for research and development work in lubrication. Mr. Kingsbury was also the winner of one of the three John Scott medals "for the invention of a thrust bearing for use in ships and heavy machinery."

The Melville Award was presented to Arthur E. Grunert of Chicago "for a thesis of exceptional merit on 'comparative performance of a pulverized coal-fired boiler using bin system and unit system of firing.'"

The other John Scott medal winners were Albert H. Emery, Jr., of Stamford, Conn., "for the invention of the Southwark-Emery testing machine, a mechanical device for testing materials," and Willis H. Carrier of the Carrier Engineering Corporation, Newark ,N. J., "for the invention of process and apparatus for cleaning, purifying and humidifying the air." The medals are gifts of the city of Philadelphia for inventions in science and industry that "may add to the comfort, welfare and happiness of mankind."

Jules Podnossoff of the Polytechnic Institute of Brooklyn was the winner of the annual Student Award, for a paper on "Pressure and Energy Distribution in Multi-Stage Steam Turbines Operating Under Varying Conditions." M. K. Drewry of Milwaukee was the winner of the Junior Award for the best paper submitted by a junior member of the society, his subject being "Radiant-Superheater Development." Robert E. Klise of the University of Michigan received the Charles T. Main Award for his paper on "Interchangeability—Its Development and Significance in Industry.'

At the general session on Wednesday afternoon Miss Frances Perkins, industrial commissioner of New York, urged engineers to give active rather than passive help to the state in accident prevention work.

The annual banquet at the Hotel Astor in the evening was in the nature of a testimonial dinner to Calvin W. Rice, who has served as secretary of the society for 25 years. Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, eulogized Dr. Rice and honorary membership was conferred upon him.

On Thursday afternoon the Robert Henry Thurston Lecture was delivered by Edward L. Thorndike, professor of education at Teachers College, Columbia University. Speaking on the subject "Psychology and Engineering," he discussed the mind as a machine, revealing some of the fundamental factors about it which he has learned in a long study of thought processes.

Professor Thorndike criticized the practice of personnel executives who attempt rigidly to classify employees for certain types of work and exclude them from all other positions. He thought the technique of psychologists better suited to determine human potentialities.

"The possibility and practicability of adult learning," he said, "will enable the world to lessen the lag of learning behind science and technology. In the present changing world much that we learn from 10 to 20 tends to be out of date when we are 40 or 50.

"In general, adults of 42 learn more rapidly than they did as children of 10 or 12. The years from 20 to 30 show better ability to learn than the years from 10 to 20. The ability to learn rises to the early twenties, remains nearly stationary for some years and then declines at the rate of about 1 per cent per year.

"Whether this rate of decline increases in the fifties, sixties and seventies is not yet known. The relevance of these facts to the problem of technological unemployment is near."

HARRY R. WESTCOTT
Manager

EUGENE W. OBRIEN
Manager

ALEXANDER J. DICKIE
Manager

Central Station Session

The three papers presented contained material of as much interest to industrial power plants as to central stations. Only the paper on the solubility of calcium salts offered information pertinent to high-pressure plants

Solubility of Calcium Salts in Boiler Water

IN THE operation of high-pressure steam boilers, the prevention of scale receives careful consideration. The question of concentration of soluble salts also receives consideration, since it influences scale deposition, carryover and turbine blade deposits. There has been a tendency to predict scale in high-pressure boilers unless phosphate treatment is resorted to above 200 lb. F. G. Straub, in a paper on the solubility of calcium salts in boiler water, presented the results of work done on this subject at temperatures and pressures up to 600 deg. F. and 1,500 pounds.

Mr. Straub first pointed out that with the data available before his present work, scale was predicted from boiler feedwater, which in practice gave no trouble. The discrepancies between theory and operation may be explained on the basis that sufficient data have not been available to formulate theories that hold at the higher pressures.

The determinations of solubility by Straub were made in a number of small steel bombs. Four constant-temperature boxes were constructed to hold these bombs. With each box at a different temperature, and with six bombs in each box, 24 separate solubility tests were run simultaneously, thus obtaining results much faster than possible by older procedure. The boxes were electrically heated by means of resistance wire, and constant temperature was maintained by automatic regulation within plus or minus three degrees.

The procedure involved in these studies were to put the desired solid phase in a larger, or bottom bomb. The desired solution was then added boiling hot and the bomb closed by screwing the top on. The smaller, or top, bomb, previously cleaned and closed, was then attached by means of the connection on the copper-lined steel tubing to the lower bomb. The valve between the two bombs was closed. The assembled bomb was put in the heating boxes and held at the desired temperature until equilibrium obtained. When it was desired to sample the bombs the valve was opened, and the steam pressure in the lower bomb forced the solution through a filter and the capillary tube into the upper bomb. When cool the top bomb was removed and the volume of solution accurately measured and completely analyzed.

Determinations were made for the solubility of calcium sulphate and calcium carbonate alone and in combination. The solubility of these salts were also determined in the presence of sodium carbonate, sodium sulphate and sodium hydroxide.

The conclusions were:

1. The solubility of calcium carbonate decreases with increase in temperature.
2. The solubility of calcium carbonate in the presence of sodium carbonate or hydrate is practically zero at the temperatures studied.
3. The solubility of calcium sulphate is not directly proportional to the sulphate in solution.
4. Calcium sulphate as a solid phase cannot exist in equilibrium with solutions containing sodium carbonate, even at pressures up to 1,500 pounds.
5. The old calculated ratios of CO_3 to SO_4 to prevent calcium sulphate formation as a solid phase are extremely high.

In the discussion R. E. Hall stated the work he had done indicated that the solubility of $CaSO_4$ first decreases and then increases as the concentration of $NaSO_4$ is increased. He also found that NaCl increases the solubility of $CaCO_3$. Experience has also indicated to him that static equilibrium solubilities as determined in bombs cannot be entirely relied upon when determining the conditioning treatment of boiler-feed water.

E. P. Partridge pointed out that the method employed in making the solubility determinations provided opportunity to make a number of cross checks which show the accuracy of the results.

The similarity of the results obtained at low and high pressures J. D. Yoder believed should serve to reassure engineers that feed water for high-pressure boilers could be satisfactorily conditioned. He questioned the zero solubility of $CaCO_3$ in the presence of small quantities of $NaCO_3$.

Performance of Modern Steam-Generating Units

IN THEIR PAPER, "Performance of Modern Heat-Generating Units," C. F. Hirshfeld and D. U. Moran presented operating data collected on 244 large steam boilers over a period of three years. This work supplements the data presented in a paper of the same title at the 1929 annual meeting of the A.S.M.E. As in the first study, information was gathered only on boilers operating at pressures above 200 lb. gage and containing over 10,000 sq.ft. of saturated heating surface. The data collected cover the period July 1, 1928, to July 1, 1931.

Printed log sheets were furnished to each operator reporting. The logs were so arranged that each day's operating data were reported for each boiler. Every factor that might have a bearing on the unit's performance was included in the log. Design data necessary for the proper interpretation and coordination of the results were obtained by means of a separate questionnaire. The following definitions were given the operators for guidance in filling out the log sheets:

1. A steaming unit is one which is passing steam to the line.
2. A banked unit is one in which a pressure approximately equal to line pressure is maintained, but from which there is no flow of steam to the line.
3. A reserve unit is one which is cold and in which the pressure is at or near atmospheric, but which may be put on the line in the time that is normally taken to lay and light the fire and bring the steam pressure up to that in the line.
4. A crippled unit is one which is in such condition that it is incapable of being put on the line within the time that is normally required to bring the boiler from cold to steaming.
5. The availability factor is the ratio between the time during which the unit is not crippled and the total time reported.
6. The use-factor is the ratio between the time during which the unit is not crippled or in reserve and the total time reported.

The data collected were given in tables and curves in the paper, together with the summary of the data collected in the previous study of 1929. These tables indicated the percentage of the total period the boilers were steaming, banked, reserved or crippled, and also the use-factor and the availability factor.

There is great similarity between the results of the two studies. The stoker-fired, pulverized-fuel-fired and oil- and gas-fired units maintained about the same relative positions in both cases, but the availability decreased slightly in all cases in the study extending over the longer period. This seems to indicate that some outages are not annual occurrences and are not necessarily

met in so short a period as a year.

The availability factor reported for the stoker-fired class is 0.831; for pulverized-fuel fired class, 0.869; that for oil- and gas-fired units, 0.864; and combined fuels, 0.927. These figures would seem to indicate a slightly higher degree of reliability for pulverized-fuel-fired equipment. The authors, however, cautioned against this conclusion; they are not yet prepared to say that this is the case.

The data collected appear to justify the assumption that larger units give greater reliability. The smaller units appear to average availability factors in the neighborhood of 0.83 to 0.85, whereas the larger units appear to give values averaging more nearly 0.90. However, it is noted that some of the smaller units give performances substantially equal to the best of the larger units, and the authors concluded that skill in design, construction and operation or the economic possibilities of individual cases actually have more influence than the size of the unit.

Maintenance man-hours on crippled boilers was reported for forty-three units. These data were analyzed and reported in a table showing the maintenance man-hours per million pounds of water evaporated classified under the heading regular overhaul, change in equipment, boiler, furnace, fuel burning equipment, economizers and preheaters, ash-handling equipment, draft equipment and instruments. They appear to indicate that size of boiler has considerable influence on maintenance; a unit having maximum continuous steaming capacity of 90,000 lb. per hour shows an approximate maintenance man-hour per million pounds of water evaporated of 6, whereas a unit of 120,000 lb. per hour heating capacity shows a maintenance man-hour of slightly less than 4.

F. S. Clark called attention to the unusual performance of a natural-gas-fired boiler in a 200,000-kw. plant that has been in continuous operation for thirteen months and upon which a record of eighteen months is being attempted.

That the maximum capacity of a boiler may frequently be greatly reduced due to some defect and the boiler continued in operation and so reported as available was pointed out by V. Alden. Some consideration should be given to this if possible, he believed, as well as the fact that about 70 per cent of boiler outage can normally be scheduled so that its outage does not affect plant operation. Very seldom is it necessary to take a boiler out of operation immediately.

Several discussors desired information concerning the causes of boiler outage and the influence on availablity of load cycle and average rating.

O. F. Campbell pointed out that in refinery practice the problem of boiler availability was greatly reduced because of the fact that three to four different fuels were often available for immediate use thus reducing outage to trouble with combustion equipment.

Influence of Inlet Box On Fan Performance

IT IS well known that the performance of a centrifugal fan may be influenced considerably by the direction and velocity of approach of the air to the inlet. For this reason the performance of an induced-draft fan with open inlet will, in general, be different from its performance with inlet box attached. The object of the test reported in this paper, by L. S. Marks and E. A. Winzenburger, was to determine the extent of the influence of inlet boxes upon fan performance. Three types of inlet boxes were investigated: a rectangular box, a modified rectangular box in which the top and bottom sides of the box were sloped about 10 deg., and a scroll inlet box—each of which were tested with and without guide vanes.

The fan tests were made according to the standard test code of the National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers, except in one minor particular. The inlet ducts were four diameters in length instead of the six diameters specified, but they were provided with rounded inlets. The power input was determined both by an electric dynamometer and by the electrical input to the dynamometer corrected for electrical losses.

The results of these tests were given by curves showing the performance obtained with each type of inlet box tested and with the fan operating with a free inlet.

A quantitative appraisal of the inlet boxes at a selected capacity and static pressure was made by comparing the necessary speeds and power consumption with those of a free inlet fan. The discharge volume selected for this comparison is of 35,000 c.t.m. and a static pressure of 3.96 in. The speed of the free inlet fan under these conditions was 900 r.p.m., and the power consumption 43 hp. The speed and power consumption with the various inlet boxes was:

Type of Inlet Box	Increase in Speed, Per Cent	Increase in Power, Per Cent
Scroll-inlet with vanes	14.8	17.3
Rectangular without guide sheets	12.2	10.5
Rectangular with guide sheets	5.3	0.7
Modified rectangular without guide sheets	0.3	—1.2
Modified rectangular with guide sheets	0.3	3.0

Curves showing the efficiency of the fan with various types of inlet boxes indicate that, with the exception of the scroll inlet without vanes, the maximum efficiencies of the fans are substantially the same. The point at which maximum efficiency occurs, however, is changed by the character of the inlet box.

The outstanding conclusion to be drawn from these tests is that it is not sufficient for the fan user to know the characteristics of a selected fan with free inlet. He needs to know also the characteristics when the inlet box is attached.

A. A. Criqui stated that an amendment to the fan test code covering the testing of fans with inlet boxes was recently approved. Tests which he had made agree substantially with those presented by Mr. Marks.

In the design of power plants, H. F. Hagen pointed out the design of flues and location of induced draft fan was often done after the rest of the plant design is completed, which results in crowded conditions at the fan and duct arrangements which reduce capacity.

Steam Table Research

OPENING the report of progress in steam research, George Orrok stated that the investigators during the year had been beset with fewer difficulties and troubles than had been experienced in previous work. He also announced that the international steam table conference would be held in Boston, Washington and New York, Sept. 12-18, 1932.

F. G. Keyes reported that work at the Massachusetts Institute of Technology had progressed to 460 deg. C. and that work had been started on the correlation of all the data collected at the Institute. He emphasized the difficulties of obtaining accurate temperature measurements when accuracy of 0.001 deg. was desired.

Dr. Smith reported on the extension of the work on the P, V, T relations of steam at the Massachusetts Institute. Superheat determinations are practically completed, while some determinations on the compressibility of water are to be repeated.

Work at the Bureau of Standards, H. S. Osborne reported, has been confined this year to the design, construction and exploratory testing of a new calorimeter with which it is hoped determinations up to the critical pressure can be made. Dr. Osborne described the new calorimeter, one of the features of which is the replacement of insulating lagging by two electrically heated silver cylinders.

H. N. Davis gave a summary of the work on the thermal properties of steam in Europe.

In industrial power plant accounting it has been general practice to debit the turbine with the heat in the steam delivered to the unit and credit it with the heat in the steam to process.

In a paper by J. H. Keenan it was pointed out that this gave no consideration to the decreased thermal availability of steam at lower pressures. He suggested the use of an availability function which considers the maximum amount of work to be derived from steam between an initial condition and a datum temperature which is determined by the temperature of the surrounding air or circulating water. This function, called availability in the paper, is given by the equation $(h_1 - T_0 S_1) - (h_0 - T_0 S_0)$ in which h and S are the enthalpy and entropy at the initial condition and h_0, S_0 and T_0 are, respectively, the enthalpy, entropy and temperature at the assumed zero datum.

Operating and Test Data on

Extra-High-Pressure Boilers

Three papers were presented at the industrial power session. One sumarized the important features of the 1,200-lb. Ford installation. The other two dealt with characteristics and test data on once-through series steam generators for 5,000 lb. pressure made entirely of steel tubing without drums

Ford Motor Company's 1,200-Lb. Steam Plant

THE GENERAL features of the 110,000-kv., 12,000-lb.-pressure turbine-generator installation in the Ford plant at River Rouge were presented in a paper by A. R. Smith and H. B. Hanson. This installation is interesting because it is an industrial power plant; it replaces and occupies no more space than equipment which had only one-eighth this capacity; and the change was made without interruption of service. The larger portion of the paper dealt with a detailed description of the plant, which has already appeared in *Power*[1] and will not be repeated here.

It will be recalled that the generating capacity of the plant was increased by substituting larger units for two 12,500-kw. turbines and reconstructing that half of the turbine room where these units were located to get the maximum turbine capacity possible consistent with high efficiency and proper operating conditions. The plan finally selected provided for two 110,000-kw. turbines in that space, one of which has been installed and is now in operation.

It was stated by the authors that as the prevailing steam conditions at the plant were not conducive to very high economies and inasmuch as four of the boilers were to be completely remodeled to increase their output it was decided to resort to 1,400-lb. steam pressure. This higher steam pressure, aside from its economic advantage, was of great importance because of the then limited supply of condensing water, or the possibility of reducing the size of the tunnel under consideration and since constructed. The possibility of ultimately providing extraction steam for general process work in the factory was another consideration for using a higher steam pressure.

The two new boilers, which occupy the same space as two of the 250,000-lb. boilers, are of the double-set, bent-tube type, with two lower, two upper, and one dry-steam drum, each having a capacity of 700,000 lb. per hour. The furnace is completely water-cooled, with bare finned tubes constituting a heating surface of 5,234 sq.ft., while the bottom is provided with a dry-ash water screen containing 770 sq.ft. of surface. The high-pressure turbine is built for 1,200 lb., 725 deg. F. temperature, and the steam exhausts at 70 lb. gage, with approximately 5 per cent moisture content at maximum output. This steam is reheated to 550 deg. and passes through the low-pressure turbine exhausting to the condenser. Steam is extracted at 288 lb., at the 80-lb. crossover, at 28 lb. and 8 lb. abs. for heating the feed water to a temperature of 406 deg., and for evaporating some make-up requirements.

No account of operating troubles was included in the paper, because of the short time that the plant had been in operation.

In discussing the paper on the Ford 110,000-kw. installation, W. A. Shoudy expressed the opinion that in designing an installation of this type there is a danger of paying too much attention to reduction in floor space to the sacrifice of accessibility, which is an important factor in industrial plant design. He questioned the value of the paper to industrial engineers in general, owing to the large capacity of the unit, stating that engineers concerned with industrial plants were essentially interested in units of 1,000 to 5,000 kw. capacity.

[1]Sept. 15, 1931.

Operating Results of a Series Steam Generator

OPERATING results of a 3,500-lb. pressure experimental boiler at Purdue University were presented in a paper, "Characteristics of a High-Pressure Steam Generator," by A. A. Potter, H. L. Solberg and G. A. Hawkins. The generator consists of a cylindrical water-cooled furnace placed immediately beneath a counterflow economizer, or convection section. This steam generator is a further development of the Calumet-type unit in that the steaming economizer, or convection element, is continued through the evaporating and superheating sections. There is no steam drum, and the water that enters the unit passes through a continuous coil and leaves it as superheated steam. It can be operated at any pressure between 1,000 and 3,500 lb. per square inch at the outlet, although in the lower pressure ranges the friction loss is excessive by reason of the small tubes used. No throttle valves or other regulating devices are installed between the boiler-feed pump and the steam generator outlet. By varying the ratio of fuel to water at any load the final quality of the steam may be changed from saturated to superheated at a maximum temperature of about 830 deg. F., this being limited by the tube material. The unit is constructed of 1 in. O.D. by ½ in. I.D. seamless-steel tubing. All joints are gas-welded, using a butt type of weld.

The feed water is delivered to the top of the convection section, where it is divided into two parallel circuits each 521 ft. in length, and flows downward counter to the gas flow. The water which leaves the two parallel circuits at the bottom of the convection section is carried to the bottom of the furnace coils by a single downcomer or equalizer. The lower furnace-coil section consists of two parallel circuits wound in the form of a cylindrical helix and discharging at the upper end into a common tube or equalizer. The middle and upper furnace-wall sections consist of two parallel circuits wound in the form of a conical helix, with another equalizer connection between the sections. The generator is fired by a single mechanical oil burner placed underneath the cylindrical furnace, the gases flowing straight upward in a single pass to the stack.

The unit is controlled automatically by a system which uses the Thyratron vacuum-tube circuit.

The efficiency of the steam generator obtained on the test was between 60 and 70 per cent within the load range at which it was operated. High efficiencies cannot be expected from a unit of this size having a short single-pass convec-

tion section. In a commercial installation this type of steam generator would undoubtedly be equipped with air heaters.

Once-Through Series Boiler

CERTAIN FACTS dealing with the design and the operation of a boiler with straight-through flow without drums was presented in a paper by H. J. Kerr.

The unit described has been in successful operation at steam pressure from 1,500 to 5,000 lb. The capacity at which the unit has been operated is about 5,000 lb. an hour, with a final temperature of 800 deg. F. The unit consists of seven circuits made of 1 in. tube ½ in. inside. Water enters the economizer section at the top, passing down through seven circuits (each circuit consisting of four double coils). At the end of the economizer section the circuits join and pass to the bottom of the furnace-wall tubes, where the flow is again subdivided into seven circuits, forming the furnace-wall tubes, which become the steaming section and superheater. There are ten coils per circuit in the furnace. Steam leaves the top of the furnace at the desired superheat temperature. It was pointed out by the author that as this type of unit obviously has little if any water- or heat-storage capacity it is necessary with variable loads to have a quick-acting automatic control which will maintain the supply of feed water, fuel and air necessary.

With the control no difficulty was experienced in operating with 30-per cent variation in load applied in one to two seconds by opening and closing the throttle valve. The outlet-steam temperature was consistently maintained within 10 deg. with a pressure variation of 50 to 100 lb. at 2,500 lb. per square inch pressure.

The feed water used in these tests was deäerated condensate maintained slightly alkaline with phosphate and caustic soda. The amount of hydrogen in the steam leaving the unit was measused at different pressures up to 3,270 lb. and was found to be in line with that normally existing in low-pressure units, and of such a low quantity as to be negligible. The quantity of phosphate or caustic required to maintain the desired pH value of 10.5 did not form any scale which remained in the tubes, but was apparently blown through to the condenser and thus recirculated through the system.

A construction detail of interest pointed out in the paper was the elimination of all flanges, the unit being completely welded from end to end, using the welds not only for tightness but also for the necessary strength. In this work resistance, arc, thermit and acetylene welding were used with complete success.

In opening the discussion on the two papers on high-pressure series boilers G. E. Orrok noted the similarity of the boiler design described in the papers with the boiler made by Jacob Perkins more than a century ago and the more recent one by De Laval. He predicted that a drumless boiler of a somewhat modified design from those described in the paper would be the high-pressure boiler of the future.

I. E. Moultrop pointed out that inasmuch as the cost of the drums represented approximately half the cost of a high-pressure boiler, if they could be eliminated a big saving in the initial cost would result. It was his opinion that there is little to be gained in efficiency by going above 1,500 lb. pressure and that the big need is to find a way of obtaining the present efficiency at lower initial cost. He emphasized the need with boilers of this type for greater reliability in feed pump equipment to insure continuity of feed-water supply and said also that the proper conditioning of the feed water was imperative.

A. G. Christie, in emphasizing the necessity of conditioning the boiler water, brought out the point that if this was done in a commercial installation with trisodium phosphate or other chemicals, as was done in the case of the boiler described by Mr. Kerr, the phosphate would be carried through the boiler and superheater and would be deposited in the turbine at about the dew point, which would transfer the necessary cleaning from the boiler to the turbine. He though that the use of a triplex feed pump, as was being done in the case of the two boilers under discussion, would tend to set up vibrations in the unit which might eventually cause fatigue stresses in the metal. It was his understanding that the efficiencies of the feed pumps used on the high-pressure installations in Europe were rather low. He said there would appear to be a need for development along that line before a satisfactory feeding unit is obtained for these high pressures.

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Business Stabilization

AT THE stabilization symposium held on Wednesday morning in cooperation with the American Management Association, Paul M. Mazur, partner in the New York banking firm of Lehman Bros., discussed financial phases of the depression problem; James W. Hook, president of the Geometric Tool Company, New Haven, offered a complete plan for the relief of future unemployment; and Dr. Virgil Jordan, economist of the McGraw-Hill Publishing Company, took up the economic aspects of stabilization.

While advocating a modification in the Federal Reserve banking system, Mr. Mazur minimized the importance of credit as a factor in business recovery. Credit, he said, depends on gold, trade and faith, but principally on trade. Therefore, any attempt to relieve bad business conditions by a change of credit policy is not likely to succeed. Improvement of trade will correct credit evils, he asserted, and the best stimulus to trade is building.

Mr. Mazur said the Federal Reserve system serves only the short-time financial transactions of industry, or about one-quarter of our present economy. It should be reorganized, he declared, to furnish four bases of rediscount: one for building, another for industrial production, a third for consumer transactions and a fourth for speculation. He pointed out the need for economic research to eliminate political inefficiency and recommeded the creation of a quasi-legal body to determine national economic policies.

Mr. Hook's plan for future unemployment relief is based on the principle that the "unemployed naturally group themselves into three classes; namely, the unemployable, the casual and nomadic workers, and the stable employees." He advocates: (1) That every community should have means for administering charitable funds for the unemployable; (2) that each community with a population of 5,000 or more should have a public planning board made up of public officials and private citizens to provide work for the casual and nomadic workers in times of depression; and (3) that every employer of labor should accept the responsibility of assisting his stable employees during depressed periods by setting aside employment reserves and benefits in prosperous times. He asked employers to cooperate in creating reserves.

Dr. Jordan declared that modern productive capacity had become so great that "prices, profits and return on capital can only be maintained by an equally rapid increase of consumption and consumer purchasing power. He declared a redistribution of wealth and income necessary, and said that to bring this about "taxation is the most powerful weapon ever devised. All that is required is the intelligence and courage for its use."

"We can," he said, "if we wish, quite simply and easily prevent oversaving, overinvestment, overexpansion of productive capacity without waiting for this purchasing power to be confiscated by competition, inflation and deflation in the cycle of boom and depression by taxing away with suitable income surtax rate and inheritance taxes all excess corporate savings and surplus individual income that cannot be spent by the recipients on consumers' goods or replacement of obsolete equipment, and spending this surplus through governmental channels for the production of free social income by building public works, parks, museums, recreation centers, roads—all of which do not offer commodities or services for competitive sale, and in the building of which purchasing power for other goods is directly released in wages."

Oil and Gas Power Division Reviews

Marine Diesels

This year the Oil and Gas Power Division centered its attention upon the marine diesel, covering the navy requirements, and diesel-electric motorship drive. An additional feature was the presentation of the $100 Rudolf Diesel Award to K. J. De Juhasz

Diesel-Electric Marine Drive

IN HIS PAPER, "Small Marine-Diesel Installations," L. B. Jackson, Fairbanks Morse & Company, discussed the "Lemp system" of marine drive, which can be considered as a combination of direct drive with diesel-electric drive.

In any marine installation the choice of proper type and number of auxiliary units is of importance equal to that of the propelling equipment. This is more particularly true in the smaller installations where the skill and knowledge of the engine-room personnel is more apt to be of inferior grade. Not only must there be proper auxiliaries, but, also, considerable care and thought should be applied to placing them in locations where they will be accessible, and in such manner as to minimize piping and wiring complications.

One advantage of the diesel-electric system of propulsion, using direct-current equipment and variable-voltage control, is ease and positiveness of control. This system, the speaker claimed, provides extreme refinement of control, for as many as 30 speeds ahead or astern are easily obtainable. Complete control of the propeller is placed in the hands of the pilot, thus eliminating mistaken signals and hence increasing the safety of the vessel and lessening damage charges. The elimination of signals to the engine room saves time and allows the engineer to devote himself to keeping the machinery in good operating condition. All of these items are of value on vessels which have considerable maneuvering to do, such as tugs, ferries and canal boats.

With this system one or more generating units may be shut down and operation maintained at corresponding full power on the remaining units. For example, in an installation using four generating units one unit may be out of commission and the ship operated at three-quarter shaft horsepower and 91 per cent ship speed; with two sets in operation at half power and 70 per cent ship speed; and with one unit at one-quarter power and 64 per cent ship speed. This distinct advantage is available only with the series-connected system using variable-voltage control. With such an arrangement it is hard to conceive of a ship being completely disabled. A unit may be taken out of service for a short period of time, enabling adjustments and repairs to be made without interfering materially with the schedule. This enables the engines to be kept in good condition and tends to reduce maintenance.

The motor may be placed well aft, making long lengths of propeller shafting unnecessary. The generating units may be placed abreast of each other, making altogether a compact layout. The engine power being divided into several units makes these units small with minimum headroom requirements. Weights are distributed and foundation problems simplified.

With this system power for all auxiliaries when at sea is taken from the exciters, which are direct connected to the main engines. Thus auxiliary power is supplied at the low fuel rate of the main engine and it is not necessary to operate a small auxiliary engine-generator set. Provision can easily be made in the control so that any main generator can be connected to the auxiliary power bus to supply power for cargo pumps or winches for cargo handling. Thus there is no necessity of having several auxiliary engine-generator sets. In fact, all that is required is a small emergency set for lighting and other auxiliary purposes. This illustrates the extreme flexibility of the drive.

Discussing Mr. Jackson's paper, Oliver F. Allen expressed the view that the electric drive should be complete rather than partial. By driving the propeller through a motor, the most advantageous propeller diameter can be employed, and the engine speed can be as high as the design permits. He also advocated the installation of two or more engines, in order to permit adjustment at sea without entirely stopping the vessel.

Louis R. Ford adhered to the view that the diesel-electric drive, while technically superior, cannot be adopted generally because of increased investment. He cited the case of a trawler that he studied, where he found that the mechanical-drive engine would cost $117,000 against $160,000 for the diesel-electric arrangement. He further contended that a direct-connected diesel could be maneuvered as easily as a diesel-electric vessel.

Inquiry concerning the clutch maintenance was made by Prof. H. A. Everett, Pennsylvania State College, who stated that his experience with marine clutches indicates that the wear is excessive and the action faulty, to which Mr. Jackson replied that the magnetic clutches have no such characteristics.

A disclaimer was made by Mr. Herman Lemp that he was not the father of the marine diesel-electric drive, although in 1920 he had suggested the idea of a multiplicity of engines and motorized propellers, which was merely an advocation of a suggestion made in a textbook in 1905.

United States Navy Diesel Requirements

COMMANDER Holbrook Gibson outlined the attitude of the navy upon the diesel question in his paper, especially treating submarine requirements. Since the signing of the London treaty, Commander Gibson stated, the navy has been confronted with an entirely new problem. We have a fixed tonnage displacement by terms of the treaty, and from that the navy must develop as many efficient fighting units as is possible. Obviously, in submarines, this means engines lighter in weight, more compact, and of more horsepower per unit of weight than have ever been obtained before. These, briefly, are the navy's requirements for diesel engines.

Shortly after the World War the navy became convinced that the four-stroke-cycle diesel engine found in the majority of the German submarines was a highly developed product and apparently had been designed especially for submarine use by the German Government. It was exceedingly reliable, maneuvered readily on air, both ahead and astern, had a fine control over a wide range of speeds.

and, in addition, was economical in fuel and lubricating oil. The most striking feature of the design was the intricate lightweight steel castings used in the construction of the bedplate and cylinder housings, and these accounted to a large extent for the reduction in weight per unit of horsepower.

The first efforts to duplicate these engines were made by the Brooklyn Navy-yard, and great difficulty was experienced in obtaining satisfactory steel castings. Several American manufacturers endeavored to make them, but finally asked to be released from their contracts on the ground that it was impossible to supply them as a commercial proposition. The latest engines built at that yard employ satisfactory castings made by the Naval Gun Factory, Washington, D. C.

It was felt that to determine with the least delay what the navy really could obtain in diesel engines it would be necessary to obtain money from Congress for experimental work. It did not seem reasonable or fair to require a diesel engine manufacturer to build an engine for the navy from specifications when it was not known definitely whether such specifications could be met. To this end it was decided to purchase a few typical engines representing what was considered to be the best and most advanced European practice and determine actually the performance of these engines, and then prepare specifications and request American manufacturers to equal or better that performance.

In the discussion of Commander Gibson's paper, E. B. Pollister, president, Busch-Sulzer Diesel Engine Company, pointed out that up to 1920 American diesel builders supplied the special diesels for navy requirements. The change in policy came when Commander Gibson sailed a war-prize German submarine across the Atlantic, supervised the dismantling of its diesels and their duplication in an American navy yard, which has since supplied such engines for the navy requirements. Existing American types of navy diesels are, accordingly, of designs made prior to 1920, and long obsolete.

Revolutionary diesel development has since occurred. American builders have kept fully abreast of Europe in modern diesel commercial types. To the advantage of both sides they enjoy arrangements for technical collaboration with all of the leading European diesel firms and have adequate technical staff and facilities for undertaking the development of suitable diesels for special navy requirements for both submarine and surface ships.

The government must pay the cost of providing special compact, light-weight diesels, whether it follows the plan outlined by Commander Gibson for the navy to purchase a few selected foreign diesels and experiment with them to develop its own designs, or abandons the present policy and supports the American diesel industry with orders for American development of suitable engines. As Commander Gibson states, the bureau has the opportunity of taking advantage of recent American development of modern compact, light-weight locomotive diesel engines which are now available for submarines, without normal expense to the government for their development.

Mr. Pollister took issue with Commander Gibson on the latter's conclusion that the trend is unmistakedly toward the double-acting, two stroke-cycle type for all navy ships from tanker to light cruiser. He is of the contrary opinion that up to 10,000 hp. units, suitable for 40,000 hp. quadruple-screw battleships of the Idaho class, the single-acting, two-stroke-cycle, trunk-piston type will ultimately prevail, mainly because this type is lower in height, more compact, far simpler, and is most favorable for the latest — and lightest — structural welded construction. Adherence to a single school of thought is dangerous in planning a future navy diesel program, considering the present state of the art.

America already holds leadership in the larger trunk-piston, single-acting, two-stroke-cycle engine, predicted by Dr. Blache as the ultimate warship diesel. In 1930 the Busch-Sulzer Brothers Diesel Engine Company accepted an order to design and build a 3,300-hp., 10-cylinder, trunk piston, two-stroke-cycle, airless-injection engine, the largest of this new type so far undertaken; and is now building, on order, a similar 2,130-hp. commercial marine unit. The weight of this type is about one-half of the former crosshead, slower-speed, single-acting type and, with airless injection, presents extreme simplicity in design and operation. The builder is prepared, with the full cooperation of the navy, to undertake the design of special light-weight diesels of this type in sizes up to 10,000 hp., and larger sizes in the double-acting type, under supporting orders that will justify the preliminary studies and research work and development costs involved.

Louis R. Ford took issue with Commander Gibson, stating that the navy was merely traveling in a circle. The first diesels the navy installed were of foreign design, although built in this country. Later other diesels of foreign design were purchased, all of which developed faults. Later the navy obtained submarine diesels from Germany and copied them in the Brooklyn Navy Yard. Now after 12 years the department throws up its hands and claims that it must again import diesels to keep up with advances in the art.

Oliver F. Allen doubted the wide popularity of the double-acting two-stroke-cycle type. He had observed, so he said, during his recent European trip that trunk-piston single-acting machines are still preferred in powers up to 500 hp.

In his closure Commander Gibson stated that he is quite convinced that American firms could develop and build suitable submarine diesels, but stated that the navy cannot place a contract with one firm without raising a storm from other builders. The easiest way is for the navy to build its own engines.

Fluid Meters

TWO PAPERS on the coefficients of discharge, read before the fluid meters session, brought out a lively discussion that covered many phases of fluid metering well beyond the limits set by the subjects presented in the papers.

The first paper, "A Study of Primary Metering Elements in Three-Inch Pipe," by Messrs. Beitler, Bucher and Barnes, of Ohio State University, presented the results of tests to determine the coefficients of discharge for a number of primary elements. This work was a continuation of that given in a paper at the 1929 annual meeting, where the results obtained by tests on elements located in a 6-in. pipe were presented.

The usual procedure included four runs on each element at differential pressures of approximately 2, 4, 6 and 9 ft. of water. The values of the coefficients for these runs were averaged and this average used for comparison with the coefficients for other orifices. The coefficients of discharge determined by these tests were presented as a series of graphs for the different elements plotted against both diameter ratio in per cent and differential head in feet of water.

The tests run on concentric orifices were first made on simple bored orifice plates. In checking seeming inconsistencies in readings it was found, under the microscope, that the upstream edge of these was slightly rounded. Another set was finished by honing the flat surfaces of the plates, and the coefficients found with this set were lower by about 0.7 per cent than those of the former set up to a diameter ratio of about 0.75. At this point the two curves cross, that for the new orifices continuing to rise. This departure of the latter curve from the customary form was not explained.

In the opinion of the authors, the orifice plate can be more accurately reproduced than the flow nozzle. They suggest a standardization of approach contour, and smoothness for nozzles, and believe that until this is done the coefficients used apply particularly to an exact duplicate only of the nozzle on which such coefficients were determined.

Both nozzles and orifices are apparently very sensitive to upstream roughness.

In the discussion R. E. Sprenkle of the Bailey Meter Company praised the results of the tests made at Ohio State University

Dr. S. A. Moss of the General Electric Company stated that in spite of the valuable work done by the authors of the papers the great variety of types of flanges, pipes and pressure taps tested have resulted in innumerable sets of coefficients, all applying mainly to the conditions under which they were determined and to which the present sets can be added.

Prof. W. S. Pardoe told of tests made by him on a brass Venturi tube showing close agreement between coefficients at different temperatures.

Pump and Piezometer Studies

Feature Hydraulic Sessions

Leakage loss, axial thrust and turbulence in centrifugal pumps; special features of design found in modern butterfly valves; results of investigations to determine a standard piezometer for commercial use; and the annual progress report were considered by the Hydraulic Division

Leakage Loss in Centrifugal Pumps

EXPERIMENTS performed at the University of California hydraulic laboratory, to study the leakage loss and axial thrust in centrifugal pumps, was the subject of a comprehensive paper by Alexey J. Stepanoff, designing engineer, Byron Jackson Company. Factors governing leakage loss and means to reduce leakage loss were studied. With a special pump, leakage was measured under operating conditions. The axial thrust in single- and multi-stage pumps was measured with a specially designed thrust bearing which indicated the thrust directly in pounds under actual operating conditions. New sources of thrust were established—those caused by unequal pressures on the impeller shrouds from the inside due to various causes, the most important of which are an uneven radial velocity distribution and cavitation. In multi-stage pumps, with impellers mounted back to back, generally considered balanced on account of symmetry, it was discovered that there is considerable axial thrust produced by unequal pressures in adjacent stages acting upon the shaft shoulders and impeller hubs extending through the walls of the adjacent stages. The conclusions arrived at in regards to leakage and runner thrust are given in the following:

The table shows the advantages of the different types of wearing rings tested over a plain ring of the same width and radial clearance, for operation at the point of maximum efficiency and for speeds from 1,400 to 2,500 r.p.m.

Type of Ring	Radial Clearance on Diameter, In.	Saving in Leakage, Per Cent of That for Plain Ring
Single labyrinth	0.0122	41.0 to 46.6
Circular grooves with rough edges	0.0170	32.2 to 35.5
Same with smooth edges	0.0170	16.7 to 20.0
Circular grooves with smooth edges	0.0294	2.2 to 4.0
Spiral grooves, single thread	0.0115	20.8 to 27.0
Spiral grooves, triple thread	0.0115	33.0 to 36.8
Spiral grooves, triple thread	0.0215	24.7 to 26.8
Stepped ring	0.0100	24.0 to 33.0

The advantage of a ring with circular or spiral grooves over a plain one decreases with an increase of the radial clearance. The spiral grooves of a higher pitch are more effective in cutting down the leakage; which indicates that there is actual pumping by the spiral groove. The percentage of leakage for the normal head and capacity increases with an increase of speed. The power to drive the rotating element with the runner discharge sealed, together with the power to pump the leakage, is considerably lower than that at the pump shut-off. For high specific speed pumps the power at shut-off is a maximum.

Axial thrust with no balancing means varies with the pump capacity, showing a minimum at capacities over the normal and a decrease at the shut-off point. Increase in the thrust for large capacities cannot be explained by the variation of pressure in the pump case. Axial thrust measured is greater than calculated, considering the forces due to pressure outside the runner.

In addition to the thrust due to unbalanced forces on the runner shrouds from the outside, there is an axial thrust due to a difference in pressure on the inside of the runner shrouds, which results from a difference in the head produced along the two steam lines near the runner shrouds and from cavitation. Of the several causes of this, the uneven radial velocity distribution is most important.

Balancing of the axial thrust by means of a chamber on the back of the runner of the same diameter as the runner suction does not eliminate the axial thrust, but reduces it to about 25 per cent for the useful part of the head-capacity curve.

With an ample clearance between the runner and the pump case, a small runner displacement from the middle position does not affect the axial thrust.

Multi-stage pumps with runners arranged in two groups, back to back, and usually considered hydraulically balanced, have an axial thrust due to a variation in the shaft diameter and the runner hubs extending through the walls separating two adjacent stages. The amount of the thrust due to this cause depends on the arrangement of stages. Axial thrust due to shoulders on the shaft and runner hubs can be balanced by making the runner hubs of different diameters.

In multi-stage pumps with runners arranged in two opposing groups the variation in the head produced by different stages causes axial thrust, as symmetry is destroyed.

The cavitation or formation and collapse of vapor-filled vacuous spaces inside the runner, manifested by noise, vibration and runner pitting, is always followed by a considerable change in the axial thrust. The direction of the thrust due to this cause depends on the location of vacuous spaces, which, in turn, depends upon the runner profile and form of the approach to the runner. Causes of cavitation are high suction lift, high velocities (overspeeding) and difference between the direction of the incoming water and the vane angle at the entrance.

Pumps with one stuffing box and one internal bearing have additional thrust due to unbalanced pressure on the inclosed shaft end. The magnitude of this thrust depends on the suction pressure of the pump.

Pressure in Pump's Casing

In the discussion on this paper attention was called to tests that showed large differences in the distribution of velocity and pressure in pump volutes. This, however, was considered as having much less effect on the pump's performance than improper suction design. It was the opinion that if the suction is so designed that the water goes into the pump correctly it will come into the volute more correctly.

Doubt was expressed as to the difference in pressure on the inside of the runner shroud being sufficient to account for any great amount of thrust. A good thrust bearing was suggested as a much better way to take care of the thrust than attempting to eliminate it entirely by hydraulic design. The efficiency of a good thrust bearing is very high and its maintenance low. If the designer is free to make the best hydraulic design without being restricted by thrust limitation, a pump having a higher over-all efficiency and lower operating costs may be obtained than when effort

is made to eliminate the end thrust completely.

The advantages of the labyrinth-type seal ring were emphasized, as the leakage through it is only about one-third that through a plain ring. Keeping down the leakage also helps to reduce the wear and increases the life of the seals. It was pointed out that leakage losses are something that cannot be seen and they may be large for a considerable time due to worn seals, before the fault is detected. For this reason anything that reduces seal ring wear may be a good investment.

Turbulence in Centrifugal Pumps

J. W. MacMEEKEN, hydraulic engineer Byron Jackson Company, in a paper, "Turbulence in Centrifugal Pumps," discussed whirlpool or vortex energy in pumps of this type, the utilization of this energy for useful work, and the effects of different kinds of inequalities in vortices. He dealt with, respectively, inequality in the forced vortex of an impeller in a centrifugal pump; waste energy in a centrifugal impeller; and the synchronization of parallel vortices in mixed-flow impellers. Brief description was given of a method for calculating head loss in river bends when the radius of curvature is known, the results obtained with which led to the development of the mathematical study of the pump. No new theory or contradiction of recognized centrifugal pump performance is introduced, but certain aspects of centrifugal pump problems are considered from the viewpoint of present knowledge of observed characteristics of the vortex.

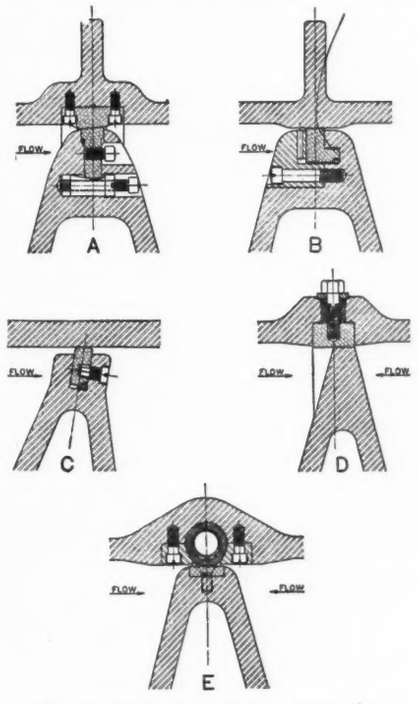
The possibility of turbulence in the water from circulating pumps, causing condenser tubes to corrode was emphasized in the discussion. Observations of many installations showed that in several cases where trouble was experienced with corrosion in condensers it was found that high-speed high-discharge-velocity circulating pumps were used. Where slow-speed slow-discharge-velocity pumps were used there was an absence of corrosion. If the water is given a little time between leaving the pump and entering the condenser tubes part of the air liberated by turbulence in the pump may go back into the water. Attention was called to three condenser and circulating-pump installations in the same plant. All three were alike except that two of the pumps were close to their condensers and the third was quite a distance away. In the two condensers with the pumps close to them serious trouble was experienced because of corrosion. No trouble of this kind occurred in the condenser with the pump some distance away. In the latter case it was assumed that the turbulence in the water leaving the pump had a chance to be corrected before it reached the condenser, whereas in the former the water entered the condenser in a turbulent condition.

Modern Hydraulic Butterfly Valves

THE important features of modern butterfly valves were described by Ross L. Mahon, vice-president, Pelton Water Wheel Company, and the progress that has taken place during recent years was shown. Difficulties accompanying the use of these valves under unusually high pressures have been successfully overcome, effective means have been devised to eliminate leakage, and by adopting special types of construction it has been possible to build them of very large size. New types of operating mechanisms have been developed capable of applying tremendous forces to the valve disks. Automatic operation has been brought to a state of dependability and perfection considered impossible several years ago, and the large number of these valves that are today in successful operation bears witness to the ingenuity and skill of the engineers responsible for their development.

Butterfly Valves Widely Used

The widespread use of butterfly valves for controlling water flow in large pipe lines proves their fitness and adaptability to this type of service. Its adaptation to free-discharge service, with water velocities that are 10 to 20 times those produced in the average penstock, is ranked as the outstanding development in butterfly-valve design in the past four years. It was the authors opinion that there is reason to believe that this type of valve, because of its simplicity of design, its reasonable cost and its inherent flexibility, has by no means reached the limit of its possibilities. The following describes a number of designs that have been used to prevent leakage through butterfly valves.



Types of seals used on butterfly valves

LEAKAGE-TEST DATA ON BUTTERFLY VALVES

Valve Diameter, Inches	Leakage Test Pressure, Lb. per Sq.In.	Leakage, C.-F.-S.
36	80	0.002
36	130	0.003
48	140	0.004
51	375	0.015
60	155	0.016
66	200	0.033
66	210	0.013
72	110	0.002
72	260	0.025
72	403	0.007
78	65	0.001
78	67	0.008
78	120	0.002
84	48	0.001
84	145	0.014
84	310	0.011
90	103	0.003
90	109	0.004
114	125	0.018
150	56	0.011
168	143	0.045
168	286	0.095
204	78	0.022

Probably the most common method of insuring a practically water-tight joint between the closed disk and the body of a butterfly valve is the use of metal seal rings. These are usually made of bronze or some similar nonferrous metal and can be attached either to the body or the disk, or to both. Their design involves a means for adjusting the seal-ring position on the body or disk to make it match accurately the surface against which it seats.

When the ring is attached to the disk it is usually made of comparatively thin cross-section and often sectionalized into several pieces with overlapping joints. It may be provided with a series of jackscrews or adjustable wedges, located in the disk as shown at *A*, in the figure. By means of these, the disk seat ring can be moved out radially to bring it into contact with the internal bore of the valve body or body seat ring.

Another type of adjustable disk seat ring is similar to that described except that it fits into a slot in the edge of the disk and is so arranged that when the disk is moved into the closed position, pressure water in the penstock from the upstream side of the disk is used to force the seat ring firmly against the seating surface in the body, as indicated at *B*.

In still another type, where the closed position of the disk is at an angle of several degrees with the axis of the valve body, as shown at *C*, the seat ring is held loosely by screws in a slot in the edge of the disk. As the disk comes to the closed position the seat ring is brought into contact with the cylindrical machined surface in the valve body and is forced back into the disk against a special packing ring placed in the bottom of its groove, and in such a way as to serve not only as a flexible backing for the seat ring, but likewise as a gasket to prevent leakage.

Another effective arrangement, shown at *D*, consists of an adjustable bronze ring attached to the internal bore of the valve body. Radial movement of this ring is effected by means of jackscrews and bolts, all of which are adjusted from the outside of the valve body. A renewable ring may or may

not be attached to the outside periphery of the disk itself.

One of the most ingenious, simple and effective sealing devices is the rubber-tube seal ring, shown at *E*. This is particularly well adapted to use on very large butterfly valves, and in its usual form consists of a heavy rubber tube set in a groove or slot in the valve body at the point where the disk seats. This tube is connected with a pressure system capable of supplying water at a pressure somewhat in excess of that which exists within the valve and penstock. As the disk of the valve is moved into the closed position this tube is deflated, and after it reaches the closed position pressure water is admitted to the tube, causing it to expand and to make a tight contact with the machined periphery of the disk adjacent to it. This arrangement has given satisfactory service. It can be varied by placing the rubber tube in the outer edge of the disk instead of on the valve body.

The fact that these methods of obtaining a tight joint between disk and body are effective in reducing leakage is evidenced by data in the table. These were obtained from various butterfly valve manufacturers and indicate the leakage that took place by test for valves of different diameters under a wide range of test pressures. All of these valves were fitted with special sealing devices to reduce leakage.

Discussion on Butterfly-Valve Practice

Attention was directed to butterfly valves that have been in operation in a hydro plant at Lawrence, Mass., for 82 years. A description of the 27-ft. butterfly valves in the Conowingo plant was given. These valves are equipped with a rubber-tube seal of the type shown at *E* in the figure. These valves have been in operation for several years and when closed are practically tight. Their maintenance has been negligible and the valves' performance was reported to be extremely satisfactory. Apparently the rubber sealing tube will last indefinitely.

The sealing tube on these valves serves two purposes: to prevent leakage and to prime the wheel case, the latter being done by releasing the pressure in the sealing tube. Conowingo operates primarily as a peak-load station. Under these conditions the units are shut down a large part of the time. To keep the water losses at a minimum the butterfly valves are closed when the turbines are shut down, which has subjected the valves to an unusual amount of service. On test the valves have been used to shut down the turbines, starting from a full load on the machines. This was accomplished without the valves showing any distress.

A disk-type valve was described that has a babbitt seat and has the operating mechanism attached to the disk in such a way as to force it closed against the pressure of the water. The babbitt seats were reported as giving good service and remaining tight over long periods.

Piezometer Investigations

AT THE Alden Hydraulic Laboratory of Worcester Polytechnic Institute an extensive investigation has been made to determine a standard piezometer for commercial use. The results of this investigation were given in a paper by Charles M. Allen, professor of hydraulic engineering, and L. J. Hooper, at the institute. In these studies piezometers were compared in operation with suitable reference orifices, the differential being measured by a hook gage. A number of factors concerning the performance were analyzed. Included in these studies were care in making connections; expression of error; surface finish of plug; agreement of reference piezometers; length of straight piezometer tubes; effects of pipe-wall roughness on piezometers; effects of whirling water; inserted tube; tea-ball piezometers; conical piezometers; and the effects of wall roughness, whirling water and improvements of meter-inlet piezometers upon the operation of a 12x6-in. venturi meter.

The following results were given as being indicated by the tests:

The error of a piezometer is a constant percentage of the local velocity head existing at the orifice.

The size of the opening has no effect within the limits tested, which were from $\frac{1}{16}$ to $\frac{31}{32}$-in. opening and mean velocities up to 7.3 ft. per second in a 12-in. pipe.

A true square-edged orifice is accurate, but sensitive to slight changes in construction and position.

A standard piezometer plug or plate must be flush with the conduit wall.

A piezometer that projects beyond the pipe-wall surface has a large negative error.

The burr must be carefully removed from a square-edged orifice.

A piezometer plate or plug is not sensitive to minute abrasions on its surface.

A piezometer orifice must continue with parallel sides for over two diameters into the plug before its shape is changed.

The inside penstock wall should be scraped clean for at least one foot upstream from a piezometer.

Piezometers to determine true pressure head should not be installed where there is any chance of the water whirling in the pipe or immediately downstream from an obstruction, such as a butterfly valve, a rivet head or a plate joint.

An inserted tube pointed on the upstream end and with piezometers on the side gives a correct pressure-head reading, but it is sensitive to angularity.

A tea-ball piezometer has a large negative error, but it is not sentitive to the direction of flow of the water.

A conical piezometer has a large negative effect, but must be used with extreme care and calibrated.

An orifice with a large radius of rounding has a small positive error.

An orifice with $\frac{1}{4}$-in. hole and $\frac{1}{16}$-in. radius of rounding is recommended for standard practice.

Opening the discussion on this paper, attention was directed to several thousand piezometer tests that were made in 1878. These tests were conducted using open flume, and it was found that the end of the orifice must be parallel with the plane of the side of the waterway for correct readings. It was decided that the error was greater with the orifice pointing upstream than when away from the direction of flow.

A one-inch tube was considered necessary to measure the differential pressure accurately. The condition of the inside of the tube has a marked effect upon the accuracy of the readings. The connections to the piezometer may be the cause of very large errors if they are not made so that the flow of water will be the same in both directions. Great care must be exercised to eliminate air in the piezometer connections and to make them tight to prevent leakage, if wrong indications are to be avoided.

▼

Fluxing of Ashes and Slags

A REPORT of the special research committee on the Removal of Ash as Molten Slag from Powdered-Coal Furnaces formed the subject of a paper by P. Nicholls and W. T. Reid, both of the United States Bureau of Mines. This investigation was to obtain data on the fluxing of coal-ash slags to enable users of slagging-type boilers to increase the fluidity of the ash should it not be possible to tap at prevailing furnace temperatures. Studies were made using a platinum-wound laboratory furnace supplemented by a somewhat larger gas-fired furnace. Plant tests to confirm the laboratory tests and to develop methods for adding the flux have not as yet been made, principally because no station equipped with slag-tap furnaces has reported it impossible to remove the slag by tapping; although it is possible that some may have experienced trouble in starting the flow, which trouble could be lessened by partial fluxing.

The fluxes studied were iron ore, limestone dolomite, fluorspar, salt-coke, steel slags and silica. Of these, the investigation showed that limestone, dolomite and iron ore, or their equivalent in waste products, are the only fluxes that need be considered, although silica may be useful in lowering slightly the flow temperature of slags having a low silica-aluminum ratio.

Indications are that limestone and dolomite are about equally effective from 2,600 deg. up. Limestone alone will give the lowest-cost flux, but its weight added to the bed will be greater than if a mixture of limestone and iron were used. Limestone can also be used for occasional fluxing, as around the taphole.

The authors presented a diagram from which the quantity of flux can be computed for the most economic mixture to meet the given conditions.

Boiler Feed-Water Studies

Foaming and Priming Of Boiler Water

IN A PAPER on "Foaming and Priming of Boiler Water," C. F. Foulk presented new information about the behavior of suspended solids and of dissolved salts as well as presenting a theory of foam formation. The paper was essentially a review of the experiments made by the author since the publication in 1926 of his previous paper on "Present Knowledge of Foaming and Priming of Boiler Water With Suggestions for Research."

As to the theory of foam, he said the major cause of wet steam is often more physical or mechanical than chemical, but even in such cases the physico-chemical properties of the water play an important rôle. In all cases that have come to the author's attention the most important chemical property of the water is the degree to which it is capable of forming liquid films. This formation of films is sometimes an obscure, but nevertheless a frequent determining factor in wet steam. Film formation, particularly a mass of spherical films, or a foam, is therefore one of the most important characteristics of a water, and has been so recognized from the first. The stability of a film was also found to be an important factor and an instrument known as a dynamic foam meter has been developed for measuring it.

Speaking on the theory of anti-foam, the author stated that various non-foaming mixtures of foam-forming substances had been found. Perhaps the most interesting one, sodium sulphate and soap. A solution of sodium sulphate in the dynamic foam meter foams vigorously because the salt is negatively adsorbed. The foaming is instantly stopped by the addition of a minute amount of soap, which is strongly positively adsorbed. This experiment shows the danger of hasty generalization in the study of foaming. As a rule, the addition of soap to a water solution makes it foam, assuming, of course, that there is no chemical action on the soap; but, it is seen, there are exceptions.

The author also described experiments for the cause of water in steam carried out on a small boiler consisting of a horizontal drum 4 in. in diameter and 5 ft. in. long into the ends of which is connected a water tube, both connections being made close to the lower side of the drum.

The boiler was first operated a number of times with distilled water, and then with solutions of various salts at different concentrations, but with no solid matter present. From these experiments it was found that the throwing of water into the steam decreased regularly as the concentration of salt in the water increased. A large number of experiments were performed with solutions of sodium chloride, sodium sulphate, sodium carbonate, and sodium hydroxide. The amount of water thrown into the steam was measured by the chemical method, allowance being made in all cases for the progressive concentration in the boiler. The experiments showed, first, that the level of water in the drum had perhaps the greatest effect, and in the sense that the lower this was the less water, other things being equal, appeared in the steam. Secondly, there was considerable difference among the salts. Sodium sulphate and sodium carbonate and hydroxide gave less water in the steam than the chloride.

Upon further investigation as to the cause of water being thrown into the steam, carried out with a glass boiler of similar size, it was found that waves were propogated along the length of the drum and the bulk of the water appearing in the steam was due to the crests of these waves hitting the steam outlet, which was on the top of the drum about two-thirds of the length of the drum from the end at which the steam entered from the water tube. These waves were highest in the case of distilled water and dilute salt solutions. As the concentration of the salts increased, the waves flattened out and not so many crests hit the steam outlet of the drum.

The paper also gave considerable space to the effect of suspended solids, effects of solid matter at higher pressures and effect of alkalinity and organic matter.

In a written discussion on Mr. Foulk's paper, A. R. Mumford presented data on the ways the quantity of moisture in steam had been reduced at the plants of the New York Steam Corporation. He gave three factors found to influence the quantity of moisture in the steam: height of water in the steaming drum, rate of steam generation, and concentration of dissolved and suspended matter. He stated that one boiler at the Kips Bay plant had been thoroughly tested to determine the relation of water level to steam quality and presented curves on which the temperature indicated by each of four calorimeters were plotted against the average level indicated by four gage glasses. He also gave results of tests made with a perforated baffle plate in the front water leg of a horizontal water-tube boiler in which the upper tubes had sagged, evidently due to lack of water. The action of the perforated plate in the circulation was to reduce the effect of high water level on the moisture in the steam so that full protection could be afforded to the upper tubes. It was his opinion that the effectiveness of the baffle was based on the rupture of bubble films.

As to the second factor, the rate of steam generation, it had been found that as the rating is increased a point is reached where moisture appears in the steam and on further rating increase the amount of moisture increases as an approximate linear function of the boiler rating.

Referring to the third factor, concentration of dissolved and suspended matter, Mr. Mumford stated that within the limits of concentration normally existing in the boilers tested, no factor other than hydroxyl ion had been found which specifically affects the quality of the steam. At the same time there is a value of concentration of hydroxyl ion above which the production of dry steam is practically impossible, and it was his opinion that a critical value of this concentration which varies with the design exists for all boilers. He said that their efforts over the past three years had been directed to the adjustment and control of the feed-water treatment so that the normal building up of the hydroxyl ion concentration would be offset by the neutralizing action of the selected salts.

The SO_4-CO_3 Ratio for Prevention of Boiler Scale

THE results of a program of research at the University of Michigan, sponsored by the Detroit Edison Company to determine more accurately, if possible, the solubility relation of boiler waters were described in a paper by E. P. Partridge, W. C. Schroeder and R. C. Adams, Jr.

The program of research was essentially one of checking the numerical value of Hall's SO_4-CO_3 ratio, it being the opinion of the authors that its true value must be appreciably greater than that calculated by Hall. It was pointed out that at 150 lb. gage pressure the value of the SO_4-CO_3 ratio calculated by Hall is 11, while recent experiments indicated that the exact value was at least 100 and may be appreciably greater. This higher value, it was said, would remove the objection to the use of soda ash as it would allow the development of 24 p.p.m. OH in the boiler water for each p.p.m. CO_3 before the edge of the embrittlement range would be reached.

The authors stated that while the calculations given in the paper are based upon small-scale work in an experimental boiler, and thus are subject to the criticism that plant operation never does succeed in duplicating laboratory results, they feel that there is no fundamental reason why any boiler operated at up to 150 lb. pressure under competent chemical control cannot be held in the region of boiler-water composition limited on the one hand by the maximum SO_4-CO_3 ratio allowable for scale prevention and on the other by the minimum Na_2SO_4-NaOH ratio which is believed to inhibit embrittlement. It appeared to the authors possible that boilers might be operated at higher pressures with soda ash as a conditioning chemical if any considerations made this desirable.

Lubrication Research

Progress Report on Boiler Feed-Water Studies

THE PROGRESS report on Boiler Feed-Water Studies, presented by W. C. Schroeder and C. H. Fellows, it explained that the work of the subcommittee this year had involved critical examination of the method generally used for examining boiler water, with a view of establishing methods for plant control and referee work that might later be recommended as standard in the industry.

Immediate consideration was given methods for the determination of alkalinity, especially that due to carbonate salts, those for dissolved oxygen and carbon dioxide and those for the determination of phosphates and silicates.

The determination of carbonate was studied in both laboratory and plant, but the work was to some extent devoted to an investigation of the accuracy of the A.P.H.A., or the phenolphthalein-methyl orange, method for the determination of carbonate, and the Winkler method.

In concluding the paper the authors summarized the essential facts as follows: It is apparent that, no matter what analytical methods are used, a representative sample must be secured or the results will be meaningless. A satisfactory way to accomplish this, in the case of obtaining samples from an operating boiler, is to filter the sample at boiler temperature and pressure and cool it at boiler pressure before it is passed into the sampling bottle.

The determination of carbonate by either of the standard methods, the A.P.H.A. or the Winkler method, does not give accurate results in solutions containing low concentrations of carbonate and high concentrations of hydroxide. An evolution method for the determination of carbonate has been worked out which will give accurate results, and which can be used in routine control work as well as for referee work. The accuracy of this method is not affected by any ions which are encountered in boiler waters.

The hydroxide concentration of a sample may be determined by precipitation of the interfering ions, phosphate and carbonate with strontium chloride, and direct titration of the hydroxide; or if the concentrations of both phosphate and carbonate are known it may be determined by titration to the phenolpthalein end point alone. These methods will give results more accurate than those obtained by either the A.P.H.A. or the Winkler method, and may be considered as suitable for referee work.

By the use of aminonaphtholsulphonic acid method for the determination of phosphate and a colorimeter, an accuracy of 0.3 p.p.m. of PO_4 may be secured on samples containing less than 40 p.p.m. of PO_4. On samples containing up to 80 p.p.m the error should not be more than twice this value.

Maximum Conditions In Journal Bearings

NO ABSOLUTE CRITERION of bearing safety has thus far been derived from practice, experiment or theory. While the operating speeds and loads which may be safely applied in practice still remain largely matters of judgment and experience, mathematical theory offers a valuable aid to such judgment in attaining satisfactory results in practice.

In a complete paper on "Optimum Conditions in Journal Bearings," Albert Kingsbury, Philadelphia, Pa., presented the results of a mathematical research which started with the development of the fundamental theories for plane surfaces of infinite width, for journal bearings of infinite width with running clearance, and for fitted journal bearings of infinite width.

Calculations were also included which supply modifying factors for the effect of side leakage (resulting from the introduction of "finite width" to the problem) on pressure, on friction and on the center of pressure, as well as the effect of viscosity change on load and friction.

The results of the mathematical development and of the modifying factors determined are incorporated in a series of tables and curves which can conveniently be used for the practical predetermination of maximum conditions in journal bearings, and not requiring the analysis of any arbitrarily chosen conditions.

Two examples are completely worked out in the paper demonstrating the practical application of these tables and charts, to the determination of maximum conditions safely possible in journal bearings.

Experiments on Bearing Film Pressures

IN A PAPER on "Pressure Distribution in Oil Films of Journal Bearings," S. A. McKee and T. R. McKee of the Bureau of Standards, Washington, D. C., summarized in graphic form the results of experiments made on journal bearings in a test apparatus.

The experiments they described had for their object the determination of the hydrostatic pressures developed in the film of a bearing under various conditions of operation.

The experiments were carried out in a special apparatus which allowed the measurments of oil film pressures at any point over practically the entire working surface of the bearing with one pressure tap and gage.

Nine tests were run, the factors changed for each test being clearance, viscosity, speed and load.

The characteristics of pressure film distribution indicated by this investigation were as follows:

1. The load applied to the bearing was in most cases wholly supported by the hydrostatic pressures in a film of the lubricant between the surfaces of journal and bearing.
2. In all the tests the pressure distribution was typical of a partial rather than a complete bearing.
3. The maximum pressure observed in the bearing for given operating conditions was usually considerably greater than the maximum pressure computed from hydrodynamic equations for a bearing with no end leakage operating under the equivalent conditions.
4. Maximum pressures observed for the various conditions of operation were from $2\frac{1}{2}$ to 4 times the load per square inch of projected area.
5. The curve showing the longitudinal distribution along any element of the bearing in the region of positive pressure approximated a parabola in shape when the bearing was centrally loaded.

Prof. L. J. Bradford of Pennsylvania State College read the results of tests made to determine oil-film pressures on a bearing $2\frac{1}{2}$ in. in diameter and $1\frac{7}{8}$ in. long lubricated by oil supplied to circumferential grooves at both ends of the bearing and at one end only. The results were shown as a series of curves. The conclusions drawn by the author may be summed up as follows:

1. With very small clearances an oil film does not form and complete separation of shaft and bearing is not secured, even at light loads.
2. When the clearance is in the neighborhood of 0.002 in. per inch of diameter oil films form for loads less than 400 pounds per square inch.
3. The positive pressures built up under these conditions are variable both in amount and location.

The results obtained on these tests were discussed, the principal points being the lack of pressure at small clearances and the apparent change in point of maximum pressure under the same conditions. Dr. H. C. Dickinson of the Bureau of Standards suggested the first might be due to lag in the gage due to the large quantity of oil which must transfer to the gage before a change in reading occurred or to the entrainment of air or gas in the oil film. The second, he suggested, might come from a shift in the point of load application.

The discussion was unanimous in praising the work done by Prof. Kingsbury as furnishing data directly applicable to practical bearing design. It was mentioned as an important means of evaluating the effect of end leakage and of changing viscosity.

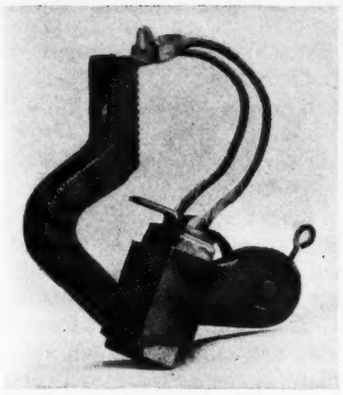


Fig. 1—Old-type brush-holder

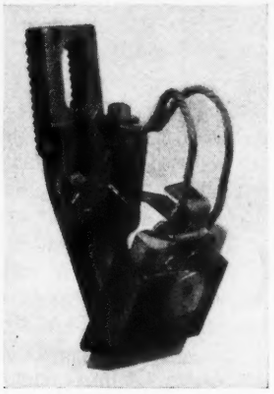


Fig. 2—New-type brush-holder

Revamping Old Converters Improves Operation

By R. H. NEWTON
Power Engineer
Westinghouse Electric & Manufacturing Company

THE Edison Electric Illuminating Company of Boston is revamping five of its 2,250-kw., 60-cycle booster converters by equipping them with new direct-current brush rigging and commutators and modern-design torque motors. These machines were installed in 1918 and after 13 years of service are being modernized to reduce maintenance costs, and to improve operating economy. The brush rigging consists of a new rocker ring and brush-holder brackets, heavier and more rigid than originally supplied with the machine, complete with new brush-holders and brushes.

Originally the brush-holders were of old-style construction, Fig. 1, and the new design is that in Fig. 2. Both types were designed for operation at approximately 35 deg. with brushes set against rotation of the commutator. A comparison of the two constructions shows that the new type permits a radial pressure component on the brush throughout its length. The new holders cover much less of the commutator surface than did the old ones. They also afford the maximum protection to springs and tension keys by having them located where they are least likely to be damaged when severe arcing occurs at the brushes.

The machines originally had commutators of the so-called 3-vee type, Fig. 3, which are being changed to those of the construction in Fig. 4. It will be seen from Fig. 4 that although bolts are used to secure the vee rings to the spider, the center-line of the spider's support is directly in the middle of the commutator bar. With this type of construction, the breathing effect necessary in commutators, if they perform equally well under all conditions of temperature, is provided for, is an important factor in maintaining good commutation. To further improve commutation with the revamped machines the commutators are being equipped with involute necks, which give a 100 per cent cross connection of the armature's winding. Maintaining a round and smooth commutator results in a direct saving in brush life.

The new torque motors being supplied, which will control the commutating-pole auxiliary-field excitation when the converters are operating at buck or boost voltages, are of the two-way type and replace the old one-way type. This two-way type, although of a much heavier and substantial construction, responds more quickly to voltage changes than the old type. It also has the advantage of being able to reverse the polarity of the commutating auxiliary coil if line disturbances cause the converter to temporarily operate inverted.

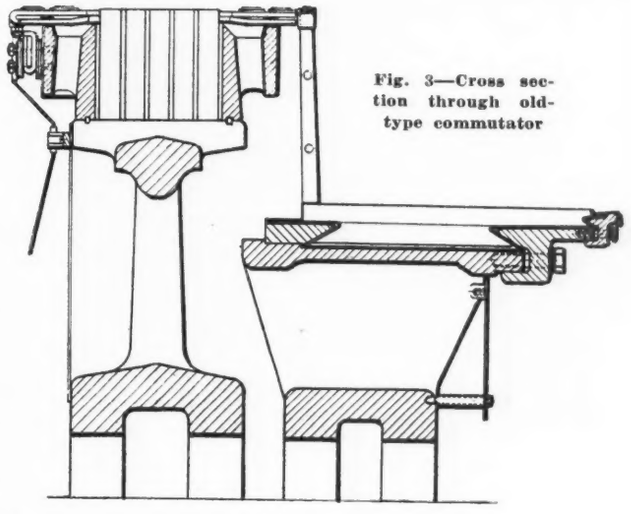


Fig. 3—Cross section through old-type commutator

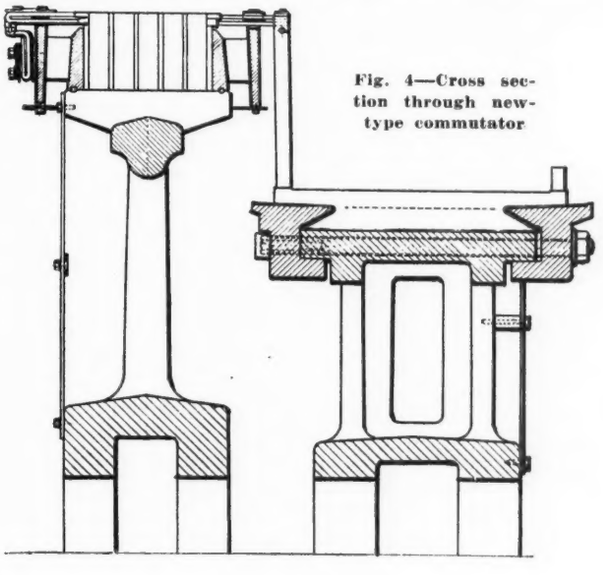
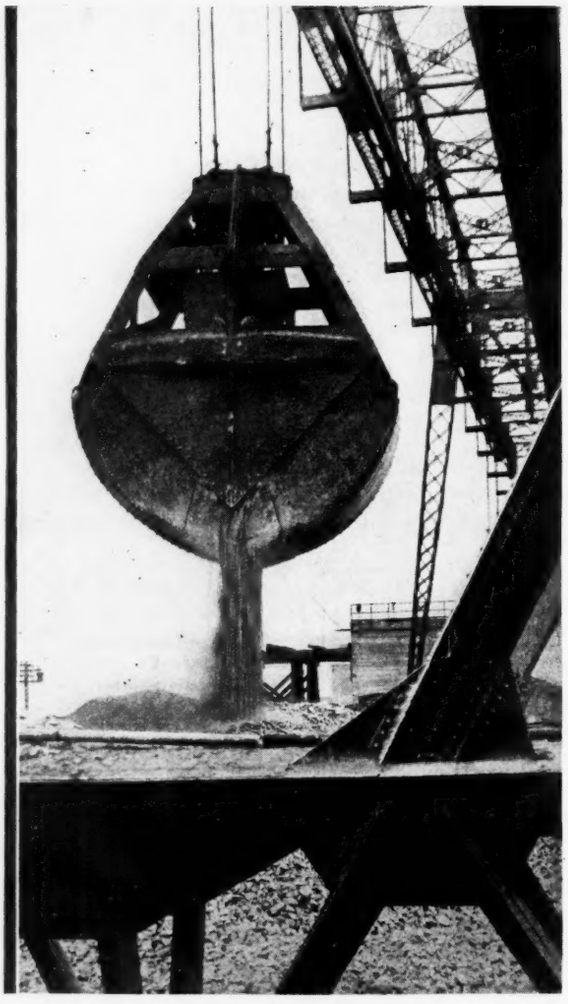


Fig. 4—Cross section through new-type commutator



COAL HANDLING IN THE POWER PLANT

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Coal handling systems consist of various combinations of certain equipment types. Economy in investment and operating charges is controlled by the simplicity of system design and the reduction of moving machinery to a minimum. Reliability, however, is the prime requisite of such systems, and this is essentially a function of the equipment itself and the way it is maintained

COAL, the raw material of steam-making, arrives at the plant in railroad cars or in barges, although a limited number of the smaller steam plants, notably in hotels, buildings, and small industrials located in the heart of congested city areas, receive small shipments of coal by truck. Whatever the means of delivery, from the arrival of the coal at the plant until the departure of the ashes, this material must be handled.

Handling by hand, practically universal in the plants of an earlier day, is no longer economically feasible. It involves considerable expenditure for labor, and, likewise, the quantities of coal used by steam plants of even moderate size well-nigh prohibit its handling by labor alone. As a result, coal in the modern steam plants, almost regardless of plant size, is handled mechanically.

Even in the first hand-fired plant, where the coal was brought into the plant in wheelbarrows and dumped in front of the boilers, a certain amount of outside storage was necessary. It not only gave greater security against shutdown, in the event of failure of coal shipments, but offered some limited possibilities for economy in the purchase and storage of coal in low-price periods.

Starting with a few cars of coal shoveled out on the ground outside the plant, the first attempt at reducing storage and handling costs was probably made by the construction of a trestle where bottom-dump railroad cars could be emptied into the storage below, without the labor of shoveling. This materially reduced the time required for car unloading and minimized the labor needed.

One of the earlier methods of handling coal into the plant consisted of a narrow-gage track running from the storage pile to the boiler house. A small dump car, similar to a mine car, was loaded at the storage pile and then run in and dumped on the floor of the boiler room for hand-firing into the boiler.

As plants grew larger, with consequent increase in the quantities of coal used, the handling costs increased likewise, and the result was a progressive mechanization of this part of the steam plant.

The principal factor involved in the selection of coal-handling equipment is reliability. Location of plant with relation to delivery point as well as tonnage to be handled influence the choice of basic equipment types forming the coal-handling system. Simplification of system design is desired so as to limit first cost, together with operating charges. However, the effect on steam production of a major breakdown of the coal handling equipment outweighs the effect on total production cost of possible variations in the relatively small increment added to total plant investment and operating charges by different equipment types.

The basic types of conveying equipment may be divided into two general classes, depending on whether they are used for vertical conveying or for horizontal and inclined conveying. Where coal is delivered by water, in steamers or barges, either to plants or to storage yards, the grab bucket and cable hoist are the customary means of unloading, with fixed or movable unloading towers.

The fixed type is usually used in connection with steam plants where the coal is conveyed directly from the tower to the bunkers of the plant. In this case, the tower and the hoisting bridge being fixed, the barge or steamer is moved alongside to present a fresh section of unloaded coal when one section has been cleaned.

The moving parts of this tower hoisting equipment are the bucket-operating mechanism, the cable, the sheaves over which the cable runs, the trolley for moving the bucket horizontally and the hoisting mechanism, generally a motor. These parts, being subject to wear, are most susceptible to breakdown, and are thus the danger points of the reliability of the system.

Wear may be minimized by proper lubrication of the cable, the sheaves and the trolley, and periodic inspection will show the worn parts requiring replacement. Care on the part of the operator to avoid jerking and whipping of the cable will reduce the danger of breakdown. While these towers are quite reliable, when properly operated, in large plants they are usually installed in duplicate. This is especially so where the coal is unloaded directly from boats to the plant bunkers, without an intervening storage pile.

This type of tower is also used for unloading coal from barges directly into railroad cars or onto a conveyor. In this arrangement the bridge generally extends through the tower, and the bucket, when filled and hoisted, is passed across to the other side of the tower by means of the bridge trolley and dumped.

The moving type of hoisting tower is generally used for the direct unloading of coal into storage. Bucket unloaders of this type are known as traveling bridges. They consist, essentially, of steel-framed horizontal bridges supported on vertical steel legs which travel on wheels on tracks. These traveling bridges usually span the storage pile. The grab bucket and its necessary machinery are suspended from a traveling trolley on the horizontal bridge. The operator's cab is also an integral part of this trolley. The bucket is moved out over the barge or railroad car, filled and raised, and is then carried back to be dumped on the storage pile, or onto a conveyor carrying the coal to the plant.

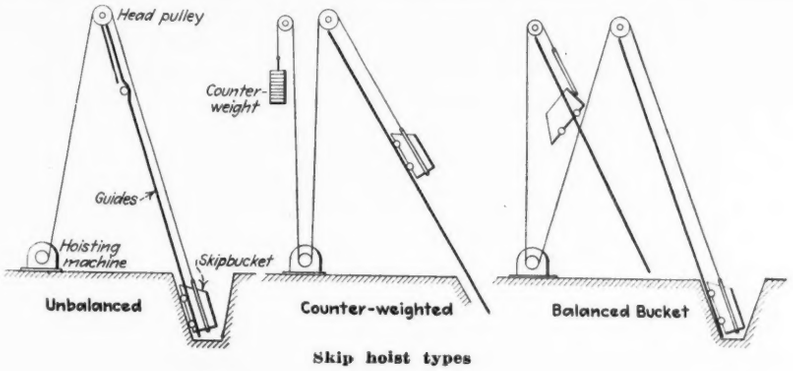
Traveling unloading bridges of this type are used both for unloading coal into and reclaiming it from storage, as well as for the direct unloading on piers and docks. Since the first cost of such traveling bridges is generally quite high, their use is restricted to installations having large capacities, where the relatively low handling cost per ton will justify the investment.

This is not necessarily so, however, with the stationary unloading towers, which are much more flexible as to capacity, as well as first cost. The type ranges from the small stiff-leg derrick rigged with a small grab bucket, which may be used for unloading limited quantities of coal from barges or cars for the small plant, to the large unloading towers which are made a permanent part of large plant structures. Bucket capacities vary from less than one-half ton to four to five tons, and tower capacities range up to 800 to 1,000 tons per hour.

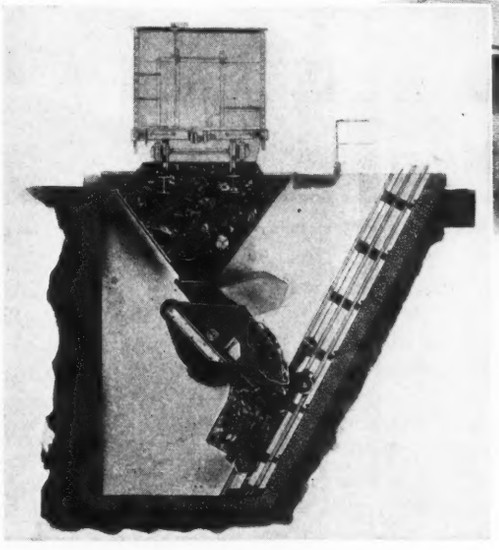
Another type of hoisting apparatus, frequently used for the raising of coal or ashes to overhead bins or conveyors, is the skip hoist. In simple form this consists, essentially, of a dumping bucket running between vertical or inclined guides and raised by means of a hoisting mechanism which winds up a rope or cable fastened to the bucket and running over a sheave at the top of the structure. Skip hoists are of three basic types, the unbalanced, the counterweighted, and the balanced.

With the unbalanced type the entire weight of the bucket and material is lifted by the hoisting engine when the bucket is being raised, and no power is required when the bucket is coming down. With this type of apparatus the variation in power demand is relatively large compared to the other types of skips. Because of this, the unbalanced skip is usually used only with small buckets and small capacities.

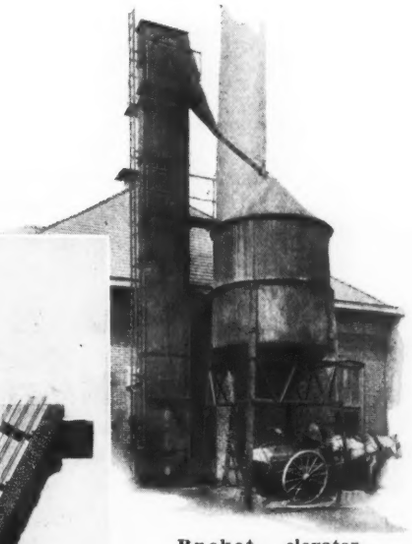
In the counterweighted type the counterweight compensates for the weight of the empty bucket, and approximately half of the weight of the material lifted also. Thus when raising the hoisting mechanism lifts only the unbalanced half of the material, and when lowering it lifts the corresponding part of the weight of



Skip hoist types



Automatic skip bucket loader



Bucket elevator and tank handle ashes economically in small plant

the counterweight not balanced by the empty bucket. The power requirement with this type of hoist is consequently lower and is also more or less constant. This type of hoist is well adapted to high capacities and speeds, and the majority of skip hoists used in coal and ash handling are of this type.

The balanced type consists of two buckets. These, running on separate tracks, are connected by the same cable, so that as one is raising the other is lowering. Thus the weights of the buckets counterbalance each other, and the hoisting mechanism lifts only the weight of the material in the bucket which is being raised, and the power requirement is practically constant. This type of hoist practically doubles the capacity of the counterweighted type, the additional cost being considerably less than double. For this reason this hoist is frequently used for very high capacities.

The capacity of a skip hoist in tons per hour depends on several factors:

1. The vertical height between the loading and dumping points.
2. The capacity of the bucket.
3. The hosting speed.
4. The time of loading.

The height of lift possible with a skip hoist is almost unlimited, although lifts of over 200 ft. are not often encountered. Additional height adds little to the first cost of a skip hoist, since the only requirements, the added rope length and the additional length of guides, represent a small part of the total investment.

The size of bucket used varies, in general, with the capacity and type of hoist used, the bucket capacities varying from one-half to four cubic yards, although skips have been installed using buckets up to 8 cu.yd. in capacity. Hoisting speeds likewise vary from 50 to 250 ft. per minute. Probably a good average speed is around 150 ft. per minute. The time required for loading, of course, depends on how the loading is done.

With semi-automatic operation the coal may be shoveled into the bucket until it is filled, or may be dumped in from a dump car small enough to just fill the bucket, or it may be filled from a hopper with a hand-operated gate. After filling the skip is started by pressing a button. The bucket rises to the top, is dumped and returned, empty, to the loading position in one automatic cycle. The principal variable factor in this cycle is the time required for loading the bucket, and this to a large extent determines the hourly capacity of the skip.

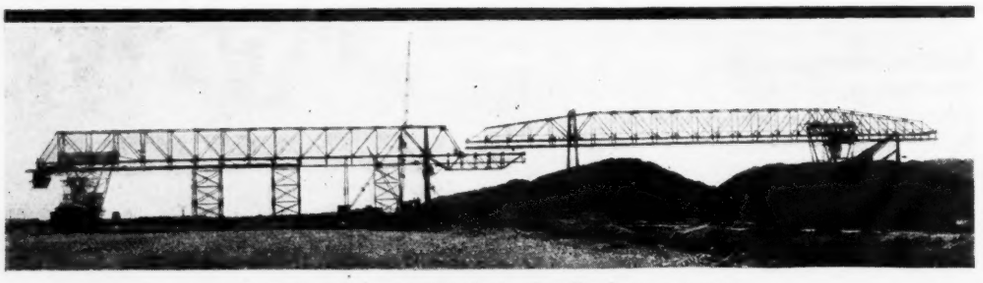
In installations where the coal can be brought to the loading hopper as fast as the bucket can take it away, the operations may be made completely automatic by using a hopper and automatic bucket loader. With equipment of this type the number of buckets dumped per hour can be materially increased, with consequent increase in hourly capacity. This type of service, however, is much more severe, and the equipment requires close inspection and adequate maintenance to avoid breakdown in service.

An important factor in the reliability of skip hoists is the travel-limiting device on the hoisting mechanism. Since the majority of the operation is automatic, the hoisting mechanism is required to raise the bucket to the proper height, to pause while the bucket dumps and then to lower the bucket. Limit switches operated from the cable drum, and controlling the energizing of the motor circuit, are usually used, together with an automatic brake on the motor shaft, to minimize drift.

While routine inspection and checking of settings will go far to minimize the danger of breakdown, due to overtravel, both the limit switch and the brake should be positive in action and permanent in setting to avoid creep. The bucket guides should be of sufficiently rugged construction to hold the bucket firmly on its path, thus avoiding the danger of jamming and cable breakage. The cable, its sheaves, the bucket rollers and the hoisting mechanism, being the moving parts and thus taking the wear, require proper lubrication as well as routine inspection and replacement when necessary to avoid the possibility of breakdown in operation.

Simplicity and directness of design and a minimum of machinery contribute materially to the reliability of coal-handling systems and to the economy of their operation as well.

[This article is the first of a series dealing with the various types of equipment commonly used for coal handling and storage and the combination of such equipment into effective and economical systems. Further articles will appear in subsequent issues.]



Traveling bridges effectively handle large storage

Keeping the Engineer Employed

What some large corporations are doing to maintain their engineering forces intact

By H. M. FRIEND

FROM the writer's recent study of unemployment among the members of the four founder engineering societies, it was found that there were approximately 10,000 out of the 60,682 members out of work, with the number still increasing. And yet during this depression we hear of industry striving, as never before, to keep employed the highest possible proportion of normal working forces even if on part time with reduced earnings. But how does this affect the engineer? The mounting unemployment throughout the profession has given force to the belief that white-collar workers, engineers in particular, are not receiving the full benefits of company plans to maintain employment.

Continuous employment, even with temporarily reduced earnings, is probably more important to technical men than to any other class. The day laborer, without resources and accustomed to a lower standard of living, can subsist on charity if necessary. But the engineer has his social level to maintain. As the engineer has created much of our material prosperity, he feels that he has the right to expect better treatment from society during an emergency. For him certain fixed expenses are required to maintain this level. If an engineer can continue to receive part of his usual earnings he can still get along by effecting economies and drawing on his financial reserves, but if he joins the ranks of the unemployed these fixed expenses cut deeply into his savings, which may soon be exhausted. He faces a struggle to maintain caste, and his situation often is more pitiable than that of man in the bread line.

Therefore the spreading of work among engineers, while putting them at a temporary disadvantage, offers the profession a means of retaining its status under the pressure of severe economic circumstances.

To secure a statement of the general situation an opinion was sought from the President's Emergency Committee for Employment, Washington, D. C. This group is staffed to work on problems regarding the promotion of employment and is probably in closer touch with present employment plans than any other organization. I quote from the answer received from K. K. Hoyt of this organization:

"So far it is believed that the practice of part-time labor or staggered shifts to avoid layoffs has been applied more to wage earners than to the salaried or white-collar class. This principle can be applied to engineering employment to good advantage.

"Where layoffs are unavoidable firms should give ample notice and dismissal compensation. They can also help employees to secure other placement or issue cash loans to tide them over.

"These practices cannot increase the present volume of employment, but they are doing a great deal to prevent a further recession among firms whose business is declining."

A report recently issued in Chicago by the Wheeler Committee on Employment Plans and Suggestions says:

"Special consideration in the effort to spread employment should be given to provision of part-time employment, at least, for the white-collar class, male and female, which heretofore has received less than reasonable notice and which represents a need and a distress often more acute than that of the industrial worker. These citizens heretofore have received less than reasonable consideration in relief measures already taken. This committee feels that, without distorting the *average* to be maintained in any national program, but rather as a parallel and supplemental effort, special consideration can and should be given them."

As the great majority of engineers are employed by corporations, their retention during a depression is dependent in many cases on the emergency methods adopted by such corporations to prevent the laying off of this group. These measures should logically lead to long-range planning and stabilization of employment policies by the large corporations, as well as a broad and just outlook on the entire subject.

With this thought in mind, a brief survey was made as to what a number of large corporations are thinking and doing on this subject so vital to the engineer. Several of the industries that are large employers of engineers were chosen. These included electrical manufacturing, power equipment manufacturing, public utilities, consulting engineers, construction companies, and mining companies. The following letter was sent to key companies in these industries:

"I am preparing a study of the present unemployment situation among professional engineers, based on data

Mr. Friend, it will be recalled, recently made a survey of unemployment among the members of the four founder engineering societies, the results of which appeared in Power, October 27, 1931. The present contribution is a timely sequel to his earlier study—Editor

obtained from the major engineering societies.

"As most of these engineers are corporate employees, their employment depends largely on the volume of business and policies of their companies in regard to the laying off of engineers during periods of depression.

"I should therefore appreciate greatly some information from you concerning the policies of your company in regard to stabilizing employment among engineers. . . ."

Of the twenty companies addressed, fourteen answered. Their letters were in most cases signed by the president of the company. Seven gave information by letter, while seven invited the writer to visit them for an interview. Some were willing to be quoted; others were not. Of the six companies that did not answer, four belonged to the same group in industry.

In general, the letters told briefly what these companies are doing in the present depression to retain their engineers; at the interviews the problems of long-range planning and stabilization of employment of engineers were discussed. In all cases the greatest courtesy and interest were shown the interviewer. It was evident that deep thought had been given these subjects and that they were burning problems.

The engineer can feel assured that management is giving great consideration to these problems and that they are nearer a practical solution than at any previous time. The writer wishes to thank the companies that cooperated with him and supplied the information which is given in this study.

"Every Effort to Continue Employment"

I shall quote from some of the letters:

United Engineers and Constructors, Incorporated, reports: "We have made and are making every effort to continue the employment of our engineers in so far as the volume of our work permits. In connection with draftsmen, we have adopted the policy of part-time employment for certain groups of men so that the work may be distributed over a greater number."

A large manufacturer of heavy equipment says: "We, in common with most concerns in our kinds of work, have found it necessary to reduce our forces considerably. In doing this we first let go the unmarried younger men who had been in our employ but a short time. When we reached the point where we were again overstaffed we commenced rotating those men we desired to keep, those who had responsibilities and who we were fearful could not obtain positions elsewhere were we to lay them off. At one of our plants at the present time about one-third of our engineers and draftsmen are working two weeks out of three, two-thirds of the force being employed at all times."

Worthington Pump and Machinery Corporation: "It is the policy of our company to retain our engineering staffs intact during periods of depression, all, of course, within the bounds of the economic limits set by the volume of business available. We have to date been fortunate in being able to retain practically all our engineers, although many of them are working on a curtailed schedule."

Foster Wheeler Corporation: "Up to the present time the Foster Wheeler Corporation has not dispensed with the services of any of its engineering staff. We hope that we can continue to carry on with our present staff."

Among those whom the writer interviewed was the American Gas & Electric Company. The chief electrical engineer, Philip Sporn, expressed the following views:

"This company considers engineers as fixed capital rather than an operating expense; not as coal which is increased or decreased with the immediate load, but as a turbo-generator which is installed not only for operating during a boom period but also for a long period of time. When this company purchases such a turbo-generator costing a large sum of money, it is only after a thorough study of the load conditions, past and present, and all other data on future prospects, and the turbine is not installed unless all that data warrant the conclusion that additional equipment is justified over a long period of time.

"This company feels that the best method of retaining its engineering force during a depression is not to overexpand it during a boom period. In other words, flatten the bulge in the engineering hiring curve. Rather than to take on all the engineers during such a peak period warranted by the work immediately available, engineers whom they will have to drop as soon as the business slows down, they resort to overtime work during the boom period.

"Again, when the company proceeds with some particularly large capital expenditure, such as a new large steam power plant, it does not build up a very large staff, which would of necessity have to be disbanded after the completion of the particular work. The policy is to engage outside consulting engineers for the job and in this way hold down the temporary expansion of the engineering department.

"The American Gas & Electric Company considers its engineers very difficult to replace. They have been picked with great care, in one instance several hundred men having been interviewed for one position. To drop such men in a depression and then take on a new group of men at a later date would be a very costly procedure for the company.

"As a result of this policy the American Gas & Electric Company has made substantial cuts only in its drafting force and by dropping a few of its junior engineers (in all cases unmarried engineers) and by putting the rest on a five-day basis with a corresponding adjustment in pay. Thus they have been able to retain substantially all of the engineering staff."

Wage Cuts Have Been Equitable

At an interview with the St. Joseph Lead Company, the president, C. H. Crane, stated that engineers should not expect better treatment during a depression than other groups in the organization. He stated that the policy of cutting salaries in corporations had been carried out from the top to the bottom, in fact with a larger percentage at the top. Not following this principle caused the recent dissension in the British navy. The pay in the lowest ranks had been cut until it was almost below the dole, while that of the higher officers and admirals had been only slightly reduced.

He believes engineers, in general, are being taken care of as well as possible during this depression. Some groups, like construction engineers, which are the hardest hit, should in fairness receive in normal times higher pay to allow for the uncertain duration of their employment.

It is his opinion that engineers would resent plans for compulsory savings by deductions from their pay, and he believes they should take care of their own financial affairs so that they can carry themselves through a depression.

At Lockwood Greene Engineers, Inc., it was stated that the deepest thought had been given to the problem of how to retain the engineers through this depression.

Every effort has been made to utilize available resources for the benefit of the men responsible for the accomplishments and the future prospects of the organization. Salaries have been adjusted and work planned with a view to providing employment and preventing unnecessary hardships. In such an organization the volume of work always fluctuates and certain classes of employment are necessarily seasonal, but in every case where the force had been reduced special efforts had been made, with some success, to find employment elsewhere for the men affected.

As the problems of spreading available work and stabilization of employment through a depression are recent developments in industry, and as this is the first test through which these plans have passed, it cannot be expected that this difficult problem has in all cases been solved.

From the results of certain of these plans now in actual practice to stabilize engineering employment the broad statement seems justified that by serious thought and planning a considerable amount of stabilization for almost any class of engineering employment can be maintained.

▼

Composite Gas Sampler For Boiler Gases

By H. F. MULLIKIN

A FLUE GAS sample from a boiler analyzed by means of the conventional Orsat is accurate only providing that a representative sample has been obtained.

To determine the flue gas analysis it is thus necessary to take samples from several points across the length of the flue gas duct. This is because a higher per cent of CO_2 will generally be found in the center than at the sides, the variation amounting to 1 per cent or more. To be strictly correct the velocity of the gases should also be taken into account, as this is also greatest in the middle. However, this variation of velocity is not great and is generally neglected.

Individual sampling of a number of points, however, introduces practical difficulties. If the analyses are not made simultaneously an error is introduced. It is difficult to operate a large number of Orsats, especially when the gas analysis is frequently made, such as for the checking of air-steam flow meters.

A sampler in which all of the individual gas samples may be mixed and a single analysis made is therefore desirable. Such a sampler should possess the following characteristics: (1) be capable of adjusting the gas flow from each individual line to any equal or relative value desired; (2) the lines must not become clogged readily and means must be provided to prevent this; (3) the gases should be bubbled through water to clean them and absorb sulphur compounds before they reach the Orsat; (4) it should be possible to check for leaks; and (5) it must be simple and rugged.

The sampler shown was developed for this purpose and performed admirably during tests. It consists of a large, wide-mouthed, inverted jar. The leads from each of the sampling positions are brought into the jar as shown. An outlet is provided at the top of the bottle which leads through a long hose to an air aspirator. The Orsat connection is made as shown, and a simple U-tube glass manometer is provided so that a constant suction of gases may be maintained by regulation of the aspirator.

The sampling lines are connected to the bubbling bottle by short pieces of gum-rubber tubing with a pinch cock to allow individual regulation of the gas flowing through each sampling line. The gas can be readily seen as it bubbles through the water.

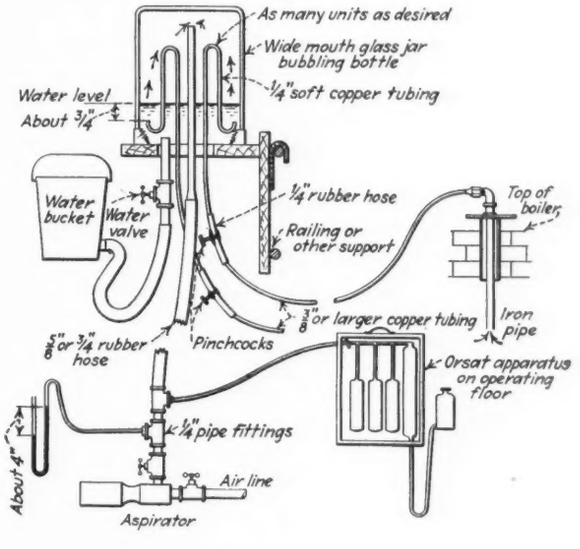
By raising the water bucket to a height above the bubbling bottle clean water will flow into the bubbling bottle. When the desired level is reached the water valve may be closed and the bucket lowered.

To insure tightness of connections it is desirable to use single lengths of copper tubing for the sampling lines with standard, copper-tube fittings. Permanent trouble-free connections are worth the additional cost. For the gas duct ordinary iron pipe may be used to 1,200 deg., F., and alloy steel pipe for higher temperatures. It should be remembered that the metal may change CO_2 present to CO, especially at high temperatures.

The sampling lines may be tested for leakage by turning on the suction and plugging up the ends of the sampling pipe with a cork. If bubbles are then observed in the bottle the connections should be examined. Any leaks in the bottom of the bubbling bottle will show as bubbles or as water leaking. The line from the bubbling bottle to the Orsat may be checked by closing the valve between the aspirator and the manometer when suction is on. If the manometer differential drops to zero a leak is indicated.

It is advisable to coat the metal bottom of the bubbling bottle with wax to prevent corrosive attack, particularly if the bottom be a zinc cover.

During the test in which the apparatus was operated iron pipe sampling tubes were used in a gas temperature



Composite gas sampler

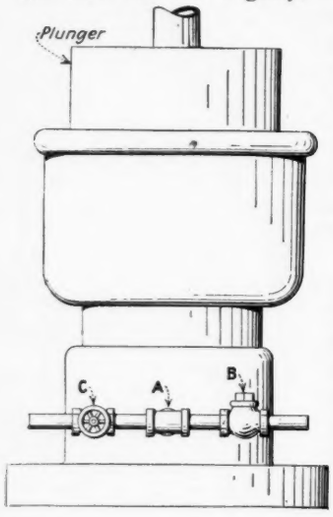
of 1,500 deg. F. for about two months. It was necessary to adjust one or two of the pinch cocks every one or two hours, although due to the large number of points sampled individual flows produced but little effect on the composite analysis.

By using the connecting hose from the bubbling bottle on top of the boiler to the operating floor it was possible for one man to take analyses every ten or fifteen minutes, at the same time taking all other needed data.

CURRENT COMMENT

Regulating Device for Corliss-Engine Dashpots

THE DASHPOTS of a 350-hp. corliss engine were a continual source of annoyance to the man in charge. There appeared to be something wrong with the admission and release of air beneath the dashpot plungers. No adjustment of the air cocks would hold the dashpots noiseless within a reasonable range of load fluctuation. Whenever the load increased perceptibly, the plungers would drop with a slam, and if the load fell off slightly, they would hang up so that the admission valves would not close entirely until the piston had reached the end of the stroke. At length the operating man decided to remove the air cocks and try the device shown in the accompanying sketch. It worked satisfactorily.



Globe and check valves substituted for air cock

Short ¼-in. nipples were screwed into the openings *A* left by the discarded air cocks. A tee on the end of each nipple branched one way to a ¼-in. check valve *B* and the other way to a ¼-in. globe valve *C*. The check valve was set to open outward. The degree of opening through the globe valve necessary to secure quiet operation of the dashpot was found by trial. Then the packing nut was jammed up tight to lock the stem in the position needed to preserve that opening. It was found that even though the load on the engine varied through a wide range, no readjustment of the globe valve was required.

As the dashpot plunger descended the air beneath it escaped through the globe valve as well as through the check. Thus the opening for escape was greater than the opening for admission, and by altering the disparity between the two openings any degree of cushion could be obtained.

D. J. ALTIZER.

St. Louis, Mo.

The Practical Man Vs. the Theorist

PERHAPS it is not a formula that is needed, as *Power* says editorially in the Oct. 6, number, but an understanding of the real meaning of theory and fact that is necessary to bring these two together. Man theorizes naturally—the practical man most of all, who cannot say a dozen words without doing so.

The art of scientific research gave rise to subsequent work of men called theorists. A hundred years ago John Herschel taught in his "Natural Philosophy" a method of scientific research not since improved upon. Later William Whewell wrote two books on "Philosophy of Inductive Science and Discovery."

Without these we should all be practical men and in the Dark Ages. Even John Stewart Mill acknowledges his indebtness to them. He failed in his effort to improve upon their method. Sir Francis Bacon never practiced the method he preached and hence discovered no new law of nature. Bacon and Mill failed to understand Herschel and Whewell in the essential distinctions between facts, characteristics, phenomena, laws and theory. Bacon tried to show existence in fact, of a fact, and the non-existences in the concrete of theories, and Mill failed on the same point. Whewell had said before them, "Theory and fact are necessarily considered as distinct and of opposite natures, and yet necessarily identical, and constituting science by their identity." While they are identical, the two words do not mean the same thing and cannot be substituted for one another. It is this lack of distinction between a theory and a fact that is characteristic of the practical man. Every true theory is a fact, but every fact is not a theory.

The Century dictionary devotes pages to these small words, which are truly scientific terms with clear distinctions. If not understood there can be only confusion. Let us look at these definitions "boiled down."

1. A fact is an observed phenomenon that can be seen, heard, felt or scented, or imagined.
2. A characteristic is a fact or a condition identical with a fact.
3. A law is also a characteristic, but broader in meaning inasmuch as it does not disclose itself without investigation and study.
4. A theory is the explanation of characteristics or laws which intend to show the cause-effect sequence, that is, the reason for things.

Practical men skip too much of this sequence of cause-effect in reasoning. Scientists follow it. Hence they bore the practical man. That the sun shines is a fact. We see the light and feel the heat; this is a fact also and a characteristic of sunlight. Then this observed effect is a fact. And when we trace it back to a cause, the reflected heat of the sun, this cause is also a fact, is it not? This sequence of reasoning, of cause-effect is simply an extended fact. But we have a true theory, which is also a fact. Facts are not, however, theories. Who could say that "Ice is cold" is a theory; yet it is a fact.

The ultimate distinction between fact, characteristics, and characteristics of a broad class called laws and their explanation, which is an extended fact, is merely the degree of difficulty of perception, or the mental ability to understand. It is simply the limitation of the untrained mind.

Every science or branch of learning comprises four steps which bear out this analysis: (1) a collection of facts of all kinds; (2) classification of these facts; (3) discovery of the laws associated with the classes in question; (4) evaluation or correct explanation of the characteristics and laws of association by theories.

Theory is considered correct when it agrees exactly with facts over a wide observation. Theory is then subjected to comparison with older theories. When it is the source of new laws and predictions it receives great prestige. So without theories, evaluation of facts, the real significance of facts would have never been perceived. Facts have existed always; theories brought to light by making use of facts. So this difference to the practical, so-called, is largely political. The two are in no sense on a parity. It is simply a difference in the degree of perception. Look up these words in the dictionary. There are several pages in the unabridged devoted to them.

ORVILLE ADAMS.

Dallas, Texas.

How Many Engineers Are Now Unemployed?

THE ARTICLE in *Power*, Oct. 27, by H. M. Friend on the subject "How Many Engineers are Now Unemployed?" is indicative of much investigation and thought upon the subject. It is a pathetic fact that the members of a profession upon whom the responsibility is due for the steadily increasing physical benefits to humanity should be the most unfortunate when it comes to the matter of steady employment. Relative to benefits to humanity produced through the professions of engineering, medicine and law, those produced through the engineering profession take first place, with medicine a close second.

The fact that so many engineers are unemployed today may be their responsibility as a profession, and due to their efficiency in the intense application of thought and research, urged on by capital in its interest to eliminate competition. Only those who have participated in business competition realize why we are in our present sad circumstances. The present depression is undoubtedly due to the fact that we were forced to stop to let our capacity for consumption catch up to our capacity for production. If there were some way of removing the selfishness of man it would help a lot to eliminate periodic cycles of depression.

The fact that there are so many professional men now unemployed does not prove the old adage of the survival of the fittest. There are at present many excellent men in enforced idleness. Many who are employed are in fear of losing their jobs. The situation, in many cases, has now come to the stage where there is an attitude of lethargy among those still employed. Which brings to mind a letter recently circulated by Martin L. Davey, president, the Davey Tree Expert Company, Kent, Ohio, wherein he states that there has never been a time when it is so easy for a purchasing agent to say "No" to salesmen who call, since they expect to be turned down. Their whole manner indicates that they are licked, and that most of them are making their calls in a perfunctory and half-hearted way.

Let us as a people snap out of it, and let those responsible stop doing things that produce doubt, fear and pessimism in the minds of the people.

Milwaukee, Wis. A. H. MYERS.

Durability of Steam Boilers

IT IS PROBABLE that steam boilers never would wear out to the extent of having to be completely discarded if they were good boilers to start with and diligent care was always exercised in handling them. The case of twelve horizontal return-tubular boilers installed by a manufacturing company about twenty-five years ago may be cited. Subsequent modernization and enlargement of the plant by the installation of water-tube boilers in large units relegated the old fire-tube boilers to the second-hand market after they had given fifteen years' service. There was not a blemish to be found on any of them. They were built to carry a working pressure of 150 lb. The insurance companies found them so good after their years of service that they were willing to underwrite them for a working pressure of 125 pounds. Instead of being consigned to the junk yard, the old boilers were sold for installation in other steam plants, and at a price higher than their original cost, owing to the general increase of values.

But special care had been exercised in the contruction of these boilers. The customer did not merely go to the market place and pick up a set of boilers ready made. He bought the material under rigid specifications submitted after consultation with insurance experts and had the boilers made to order. A qualified inspector was hired to inspect the plates as they came from the rolls. The inspection was drastic, more than sixty plates being rejected in picking a supply that conformed to the rigorous specifications. The tubes were selected in the same manner. A contract with one of the leading boiler manufacturers was then drawn up, under which the boilers were built according to plans approved by the insurance company, and an inspector was kept on the job while the work was going on. Every rivet hole was checked for perfect alignment and every rivet was critically examined before and after it was driven. When the boilers were finished, every structural detail in them was as nearly perfect as could be.

And the treatment the boilers received after they were set up in the plant accorded fully with the care that had been exercised in building them. They were connected up in batteries of two each. Five of the batteries were needed to handle the full load, so there always was one battery standing by. When a battery was cut out for cleaning and inspection it was allowed to stand for twenty-four hours to cool off. The boilers then were emptied and refilled with clear warm water. They were allowed to stand so for twelve hours, after which they were drained, cleaned, filled with fresh water, fired up and put back into service, about eight hours usually being consumed in building the steam pressure up to the working value.

Cincinnati, Ohio. J. ALLISON.

Handling Irregular Condensate Return

THE QUESTION of condensate from a heating system being returned to the feed-water heater in an irregular manner, discussed in the Oct. 13 number, brings up a similar problem which occurred in our own plant.

The heating load consists of school buildings, which are equipped with direct radiation and mechanical ventilating systems, and as the latter are operated only part of the time the condensation return is sometimes much in excess of the feed-water requirements. The installation of a surge tank as suggested in the Oct. 13 number was considered, but was found impracticable, as some of the vacuum pumps could not develop sufficient pressure to raise the water to an elevated tank.

A float box was installed alongside the heater, just below the overflow level, making connections between the top and bottom of the heater and the float box so that the water levels would be the same. The float box contains a float valve arranged to open when the water level rises and close when it falls. A hydraulically operated valve is installed on a branch of the condensation return line so that when the valve is open part of the condensate is free to flow to a storage tank at a level lower than the heater. Water at a constant pressure is supplied through a needle valve to the float valve and the cylinder of the hydraulically operated valve, the needle valve being choked so that when the float valve is open there will be insufficient pressure to close the hydraulically operated valve and allow part of the condensate to run directly to the storage tank.

Altoona, Pa. A. R. MARKLAND.

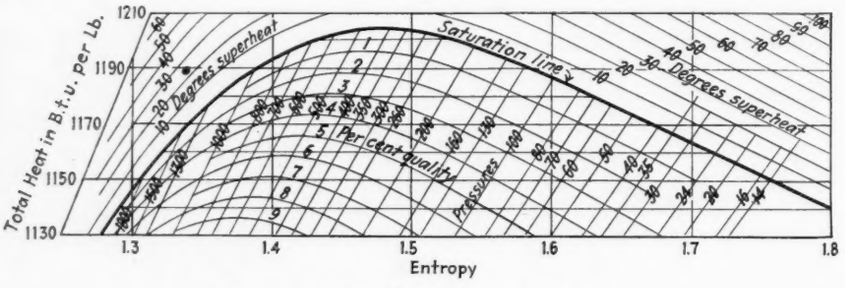
READERS' PROBLEMS

Conducted by L. H. MORRISON

USE OF STEAM CALORIMETER FOR HIGH PRESSURES—*Is it possible to employ a steam calorimeter to determine the moisture in high-pressure steam? Somewhere I have read the statement that because the maximum heat content occurs at 425 lb. it is not possible to use a calorimeter for higher pressures.*

C.M.R.

The operation of a steam calorimeter depends upon the fact that after throttling the steam has a temperature several degrees above the saturation temperature at the lower pressure. Since the total heat remains constant, it is then possible by ascertaining the degree of superheat to calculate this total heat and then the quality of the steam before throttling.



Part of a Total-heat Chart for steam

Obviously the lowest throttled pressure is atmospheric, and 10 deg. of superheat is about as low as can be used in the calculation. If then, we draw a line coinciding with the total heat line on a Mollier diagram from 10 deg. superheat and 16 lb. abs. pressure it will be possible to find the per cents of moisture in steam at various pressures, shown by the intersection of this total heat line and the quality lines. In the illustration a part of the diagram is reproduced. If a constant heat line be drawn from the 16-lb. 10-deg. superheat point it will be seen that the calorimeter will measure per cent of moisture in steam at various pressures when the per cent moisture, or quality, is below that listed in the tabulation.

Pressure, Lb. Per Sq.In.	Maximum Moisture, Per Cent
100	4
200	4.7
300	5.2
400	6.2
600	6.3
800	6.2
1,000	5.2
1,500	2

RECEIVER CAPACITY—*What is the correct formula for calculating the proper size of the receiver of a compound steam engine?*

W.R.C.

There is no formula for receiver size or capacity. If the receiver were of infinite capacity the back pressure on the high-pressure cylinder and the admission pressure of the low-pressure cylinder would coincide. Taking, for example, a cross-compound engine with no receiver at all, when the high pressure exhaust valve opens, passage is open to the low-pressure cylinder, whose steam valve is in the open position. The high-pressure back pressure will then be low, as will the steam pressure in the low-pressure cylinder. As soon as the low-pressure cutoff occurs the steam forced out of the high-pressure cylinder will be compressed in the connecting pipe, so that the back pressure will rise. As soon as the steam valve on the opposite end of the low-pressure cylinder opens, which will occur when the high-pressure piston is at about half stroke, the low-pressure cylinder volume causes the pipe pressure to drop again. When the high-pressure exhaust valve closes, the low-pressure steam line drops, to rise again when exhaust occurs on the other end of the high-pressure cylinder.

With an infinitely large receiver there would be no variation in the high-pressure exhaust pressure, which would coincide with the low-pressure steam line.

The influence of the receiver is to increase the maximum pressure in the low-pressure cylinder, increase the work in this cylinder and reduce the work done by the high-pressure cylinder.

It is customary to have the receiver equal to the low-pressure cylinder volume.

REMOVING OIL FROM KILN PIPING—*Please tell me the best method of cleaning lubricating oil from the piping in dry kilns. Will you also please advise the most satisfactory method of keeping this oil out of kilns when exhaust steam is used for heating them?*

D.T.

Since lubricating oil is a mineral, it is impossible to form a soluble soap by adding sodium hydroxide or potassium hydroxide. The oil is probably united with the condensate to form an emulsion which is difficult to remove. It is suggested that trisodium phosphate and water be pumped into the coils and allowed to remain 24 hr. This may loosen the oil. It is advisable to try the experiment on one or two coils at first. You should install one of the high-grade oil separators available for this type of application.

▼ ▼ ▼

Excessive Crankcase Lubrication Of An Oil Engine

THE QUESTION

WE HAVE three 14x17 six-cylinder two-stroke-cycle crankcase-compression diesel engines on which the lubricating oil consumption is high. I assume that the excess oil is pulled up into the cylinder along with the scavenging air. Is it possible to install a baffle to prevent this?

E.M.R.

ENGINEERS are no more in agreement upon the cause of the trouble than are economists upon the basic reason for the business depression.

As might be expected from a designer of another type of scavenger, James M. McIntosh, Cleveland, Ohio, assumes the engine is in good operating condition otherwise, and so attributes the difficulty to the arrangement or location of the intake air valve and the scavenging-air transfer port. He states that the first and usual cause of oil waste is due to defective air-transfer port design, and where the lower end of this port opening is at the upper portion of the crankcase there is a direct way to deliver oil particles with the air being transferred. The second cause, he claims, is the use of splash lubrication and an abnormal oil level which permits the crank arms to dip and splash, causing large particles of lubricating oil to be kept in suspension to be delivered into the transfer port.

As a relief, Mr. McIntosh recommends that the delivery of the air supply at the transfer port side, by reversing the crankcase doors, one of which carries the intake, or suction, air valve, will deflect the vapors away from the transfer port and modify conditions greatly. This applies in case the engine turns in the clockwise direction and the transfer port is on the left of the

cylinder axis and the air inlet valve is on the right-hand side of the crankcase.

In place of changing the doors, the same result could be obtained by reversing the engine, but it is not impossible to use suitable baffles to protect the transfer ports against abnormal oil vapor, he concedes. Where a grid air valve is used, the air can be deflected upward so that the flow will drive the oil vapors down or will keep the lower strata in the crankcase more stagnant due to the travel of the air over the upper end of the crankcase, where the inlet valve is opposite, and if on the same side as the transfer port the deflector will be equally effective in stopping the flow of oil vapors.

IN THIS he has the support of Grady H. Emerson, Birmingham, Ala., who feels that it is possible to baffle the scavenging-air ports with some sort of vanes similar to those used in separators. These baffles, he thinks, would tend to remove the oil from the air and allow it to drip back into the crankcase.

WHILE conceding that a baffle could be incorporated in the design of this type of engine, possibly on the principle of the exhaust steam oil separator, C. A. Moore, Radville, Sask., declares that the application of such a device to an existing engine would be a doubtful proposition, owing to space limitations in the usual form of air transfer port.

THIS is supported by L. R. Baker, Cleveland, Ohio; he writes that while he has never seen a successful screen used as he suggests, he has seen several wrecked after engineers had tried to use them. The reason for this is that a screen to be effective must have a very fine mesh and a large area, so as not to impede the scavenging charge. A fine screen soon has many of its openings clogged by tiny bits of carbon, scale or what not, and may be blown entirely away. If any one doubts this, let him strain a drum of new lubricating oil through a 200-mesh sieve and see what he finds. The refiner cannot help this, as loose dirt will get in from tanks, pipe lines and drums, to say nothing of dust from the air. [Mr. Baker, however, is visioning a mesh screen rather than a baffle screen, which would be the logical design to install, if any—Editor.]

SIMILAR doubts as to the advisability of baffles are expressed by Elmer N. Anderson, Austin, Minn., and by E. C. Cameron, Kellogg, Idaho, both of whom feel that space limitations and danger of displacement make the baffling idea valueless. Mr. Cameron suggests that the oil level in the crankcase may be carried too high, with the result that the crank dips into oil and sprays it into the air charge.

BACKED by experience with engines of the type under discussion, B. H. Woodruff, Meridian, Miss., has no patience with the idea of adding attachments to an engine. He observes that the lubricating oil for the connecting rods is supplied by a mechanical feed; since this is the case, there is no possibility of pressure causing an oil spray in the crankcase. The drops of oil thrown off the crank are liquid and will, he claims, adhere to the walls of the crankcase as they drain back to the sump and onto the pump sump.

After these engines are worn in, the amount of oil required for the satisfactory lubrication of the cylinder walls is a fraction of that needed when the engines are first put into commission. It is possible that too much oil is being fed to the cylinder walls. The kind of oil used is most important with this engine, and one of the approved brands only should be applied. He recommends that several of these oils be tested to see which one does best.

VISCOSITY of the lubricating oil is, so G. H. Emerson feels, the shibboleth of freedom from operating trouble. It might be possible to raise the viscosity, and he suggests that an oil of 500 to 700 sec. Saybolt at 100 deg. F. is most suitable for diesel engines. Worn piston rings, cylinders or piston, he adds, would, of course, cause high oil consumption. The engine may be running abnormally hot from some cause.

THRUSTING ASIDE the baffle prospect, E. N. Anderson says that abnormal lubricating oil consumption in a diesel engine can be caused by a number of conditions, such as excessive feed to the pistons; faulty rings, improperly fitting rings or ring grooves gummed up or carbonized, and blowby due to worn pistons or rings.

Excessive lubricating oil fed to the pistons will cause a larger amount to be worked up above the pistons, to be burned with the fuel oil or blown out with the exhaust. This abundant feed will also tend to gum up and carbonize in the ring grooves.

When the rings become fouled with gum or carbon, preventing their free movement, they either allow the oil to be blown by into the crankcase or the ring bears so hard against the cylinder wall that the oil is scraped away and burned above the piston. If scraped downward it forms an additional spray, which can be picked up by the scavenging air and carried into the cylinder to be burned or through into the exhaust. If the rings are fitted too tightly the same scraping or rubbing action takes place along with excessive wear of the ring and cylinder wall.

Worn cylinders and rings permit the gases to blow by the piston and this carries the oil into the crankcase in a fine spray or fog, to be finally carried on up into the combustion space by the scavenging air.

The remedy for excessive oil consumption is, of course, correcting the faults. This means cleaning the fouled rings or replacing the worn rings and pistons and reboring the worn cylinders. With the engine in first-class shape the oil feed should be reduced to the minimum. For the size of engine given, this would be approximately 20 drops per minute for the cylinder lubrication. However, due to varying conditions and oils having different lubricating values no definite rate of feed can be given, but the above named amount should be safe.

THE SUGGESTION that a Sherlock Holmes be permitted to go over the engine is made by W. M. Dingwell, Walthill, Neb., who operates an oil engine plant. He lists the process whereby possible clues may be found as follows:

1. Is an oil recommended by the engine builder used?
2. Is the crankcase oil level low enough?
3. Are the piston rings free in the grooves?
4. Is the ring end gap correct?
5. Throw away all rings having excessive gaps.
6. Are two-piece rings used? They should be if the engines are old.
7. Do rings contact all around the cylinder?
8. Are the cylinders worn? If the wear is over 0.147 in. the cylinders should be rebored or replaced. [This amount of wear is so excessive that an engine will not have enough compression to fire the fuel.—Editor.]
9. Are the cylinders scored? If not badly, the surface may be made smooth with a hone stone.
10. Is the oil feed to the cylinders greater than the builder recommends?

By following this procedure of clue elimination Mr. Dingwall feels that the real cause of the excessive fuel consumption will be discovered.

But what is an excessive lubricating oil consumption? The A.S.M.E. Power Cost Committee found that it ranged from 5,000 kw.-hr. to as low as 200 kw.-hr. per gallon.

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A Question for Our Readers

WE HAVE HAD considerable difficulty in the past with oxygen corrosion in the boilers. This difficulty was finally eliminated by the use of sodium sulphide in conjunction with an open heater to remove the last vestige of oxygen after the water leaves the heater.

In reading Power *I notice reference to the use of ferrous hydroxide for this purpose.*

Attempting to investigate this matter, I have been unable to get any information on the subject and would appreciate the advice of Power's *readers as to the relative efficiency and cost of this treatment compared to the sodium sulphide treatment.*

H.P.S.

Suitable answers from readers, if received promptly, will be paid for when published

WHAT'S NEW IN PLANT EQUIPMENT

Pressure Grease Gun to Lubricate Elevator Guide Rails

DURING the past year the Westinghouse Electric Elevator Company, 1500 North Branch St., Chicago, has introduced an inertia-pressure-type guide rail lubricator consisting of a power-operated pressure grease gun, driven by its own inertia whenever the elevator changes its speed. This gun, which will develop a pressure of approximately 40 lb. gage, forces its charge of special grease out through a flexible tube to a distributor mounted directly above the traveling guide shoe, where the lubricant is forced against the face and sides of the rail and the excess retained in the pocket formed by the top of the guide shoe and the distributor. From this point the grease is distributed over the rail to a uniform thickness of approximately 0.003 in., an amount sufficient to cushion the car, improve the riding qualities, eliminate noise and reduce friction to a minimum.

Operation of this grease gun will be understood by referring to Fig. 1. The lubricator itself consists of two parts. The upper half comprises a housing with a movable cap, the driving mechanism and a plunger or piston with its feed shaft. The lower part is a cylindrical grease container of proper size to receive the piston, together with proper fittings for the flexible metal hose leading to the distributor. The weighted lubricator cap is balanced by an adjustable spiral spring, so that it floats on its bearings sensitive to changes in acceleration. When the elevator is started or stopped the cap rocks up or down from its own inertia. This movement is transmitted in a positive direction to a driving wheel through two knurled rollers, one on the moving cap and the other in the housing. The wheel, in turn, drives a worm which is geared to the piston feed shaft. A clutch is provided between the worm gear and the feed shaft, which may be released by a special key that fits over the head of the shaft and may then be used either to force additional grease onto the rails when the equipment is first put into service or to return the piston to the upper housing so that the lower container may be refilled. The distance through which the lubricator cap may swing is controlled by an adjustable buffer, which permits accurate regulation of the amount of grease supplied to the guide rail per car movement.

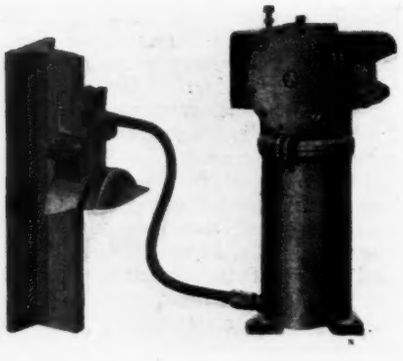


Fig. 1—New Westinghouse pressure grease gun, for lubricating elevator guide rails

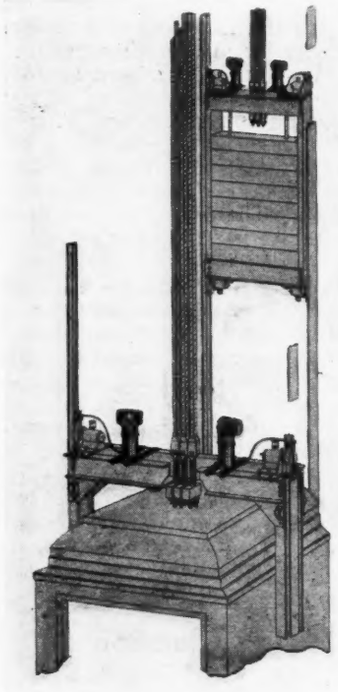
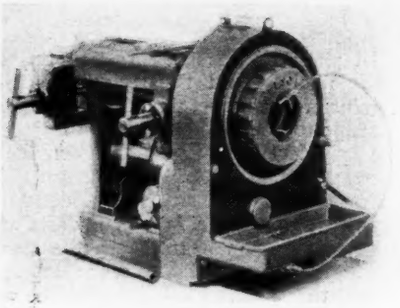


Fig. 2—Arrangement of lubricators on car and counterweight

The distributor, which is bolted to the top of the guide rail, maintains a babbitt bearing against both sides of the rail under spring pressure. Four of these lubricators, which weigh about 18 lb. each, are generally provided, one for each guide rail. Two are mounted on top of the car and two on the top of the counterweight, the general arrangement being shown in Fig. 2.

Under usual conditions, to maintain the proper protecting film between wearing surfaces it is necessary to use a lubricant of high viscosity that will cling to the rails and maintain a constant and even film for the elevator to ride on. To fulfill these requirements a special grease has been selected that is claimed to be consistently viscous at normal operating temperatures; has a low soap content, resulting in a body that is nearly all mineral lubricant; and does not contain any animal fats to cause corrosion.



Axelson portable pipe machine

Portable Pipe Threader

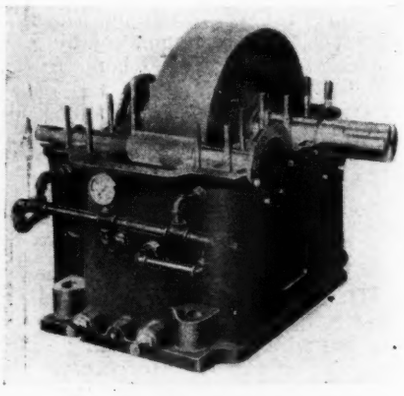
DESIGNED to handle pipe in all sizes from ½ to 2 in., the improved portable pipe threader now being put out by the Axelson Manufacturing Company, Los Angeles, Calif., is compact, weighing less than 190 lb. It is powered by a universal reversible motor, and may be used on any 110-volt circuit. Bolt-threading dies may also be used, although they are not furnished as standard equipment.

In the improved threader a standard square die is revolved on the pipe rather than revolving a length of pipe through a die head. This principle is said to insure a straight thread and permits running thread on long pipe stands. The machine embodies such features as automatic feed, cutter head or reamer quickly installed in place of threading die, oil pump lubrication and automatic self-centering jaw chucks.

High-Speed Gear Units for Increasing or Reducing Speed

A SERIES of gear units suitable for speeds up to 6,000 r.p.m., and powers from 120 to 2,500 hp., with ratios up to 10 to 1, for either increasing or reducing speed, is announced by Farrel-Birmingham Company, Inc., 344 Vulcan St., Buffalo, N. Y.

The gears used in the new series are the Farrel-Sykes herringbone continuous-tooth type. A complete lubrication system is provided, together with an oil cooler consisting of a coil of copper pipe placed in the bottom of the gear case. Forced lubrication is provided for



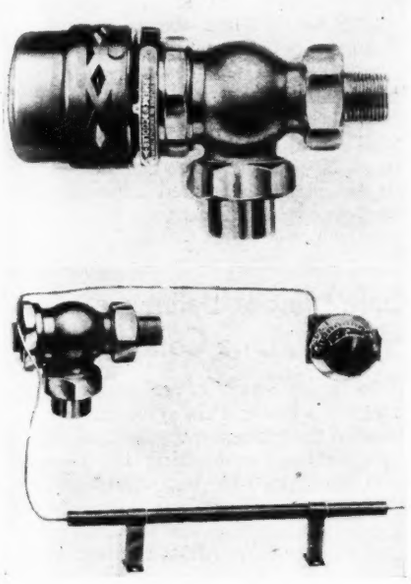
Gear unit with cover removed

all bearings and spray lubrication for the gear teeth. Bearings are steel or bronze shells lined with babbitt.

The new series is said to be especially suitable for connecting diesel or gas engines to centrifugal pumps. The latter usually operate at speeds ranging from 1,200 to 3,600 r.p.m. and the larger engines at speeds from 225 to 600 revolutions per minute.

Radiator Valves for Concealed and Exposed Radiation

TWO IMPROVED types of radiator control valves for use on any two-pipe steam, vapor or vapor-vacuum heating systems



Views of angle-type valve for exposed and concealed radiation

are announced by the Fulton Sylphon Company, Knoxville, Tenn.

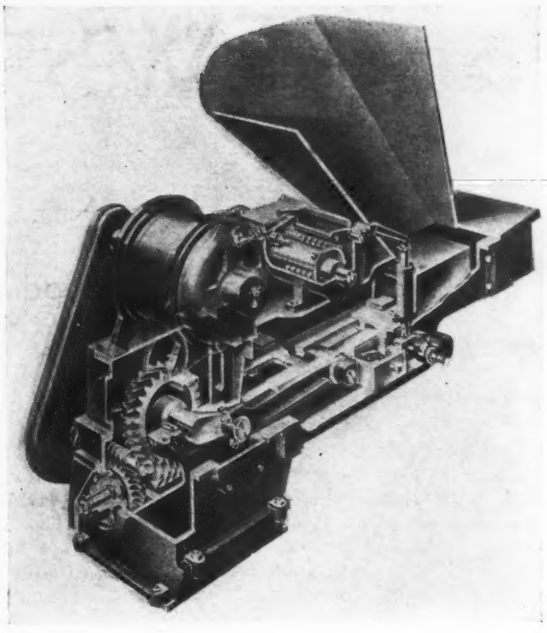
The valves, which are furnished in both globe and angle type, utilize the standard sylphon metal bellows as the thermostatic member for controlling the valve admitting steam to the radiator. The valve is of the packless type, eliminating the stuffing box with its friction to movement of the valve stem.

The automatic valve for concealed radiation shown in the lower view offers balanced heat control. By the use of two bulbs located inside the radiator cabinet it regulates the room temperature by means of both the temperature of the air entering the inclosure and the temperature of the air leaving the cabinet.

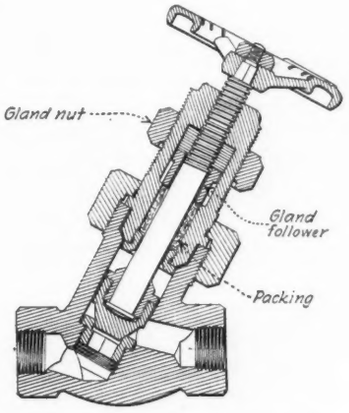
Electric Drive for Types E and K Stokers

THE ELECTRIC stoker drive illustrated is now available as standard equipment for both the Type E and Type K stokers put out by the Combustion Engineering Corporation, 200 Madison Ave., New York City. The drive is applicable wherever the steam pressure is insufficient for the standard steam drive or where other conditions favor the use of an electric drive.

It consists of a constant speed alternating-current or direct-current motor operating the driving mechanism through a gear box containing a double worm drive. Variation of coal feed is accomplished by varying the number of strokes per minute while keeping the speed and length of the stroke constant. This is done by changing the length of the rest period between strokes by a special timing device. For stokers requiring not more than 7,500 c.f.m. of air the fan is an integral part of the drive unit. For stokers requiring larger quantities of air a separate fan unit is provided. No clutches or variable-speed device is used in the drive. It gives constant length and speed of feed stroke, and the safety shear pin is at the front of the gear box, where it is readily accessible.



C-E electric stoker drive



Forged steel globe valve with swivel disk

Forged-Steel Valves for High Pressures

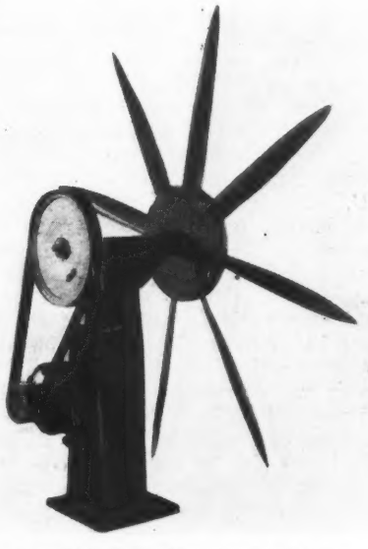
THE ILLUSTRATION shows a design of forged-steel valves now being put out by the Chapman Valve Manufacturing Company, Indian Orchard, Mass. The new line includes globe, angle and check valves of forged steel especially designed for use on high-pressure steam lines and oil refinery work. Bodies and caps are of forged steel, and the working parts may be of monel metal, stainless steel or nitralloy. The valves are made in various types—with union bonnet or flange bonnet and with swivel plug seat and disk or integral plug seat and disk. Sizes available range from $\frac{1}{4}$ to 2 in. for pressures up to 600 lb. and $\frac{1}{4}$ to 1 in. for pressures up to 1,500 pounds.

Multi-Blade Fan for Forced-Draft Cooling Towers

MULTI-BLADE indirect-connected fans as illustrated are now being used exclusively in the forced-draft cooling towers manufactured by the Marley Company, 1737 Walnut St., Kansas City, Mo.

Through the use of this large-diameter, multi-blade fan operating at comparatively slow speed the peripheral tip speed is cut in half, thus providing more quiet operation. All blades are mounted individually on a common hub and are readily adjustable or removable to meet actual operating conditions. Fan speed is readily increased or decreased by changing the sheaves of the V-belt drive. The hubs and blades are of aluminum alloy, and roller bearings are used.

In addition to the indirect-connected fan unit illustrated a direct-connected fan unit is also available for use where requirements are for higher pressures or for smaller fans with reduced volume.



Multi-blade indirect-connected fan

NEWS of the FIELD

"Interconnected" Regulatory Bodies Urged in Annual Report of Federal Power Commission

DECLARING that the "regulation of power is primarily and essentially economic and not political," the Federal Power Commission in its annual report made public Dec. 2 urged "cooperation in spirit and practice between state and federal agencies" as essential "to a proper conservation and development of the water resources of the country in the interest of the people."

"With the principle in mind that federal regulation should supplement and complement local or state regulation, cooperation between commissions becomes in practice simply a joint effort to insure 100 per cent regulation," the report states.

In furthering the work of regulation through the marshalling of facts, the Commission says, "federal leadership promises substantial results. No single state is sufficient unto itself to undertake unaided the task of finding all the pertinent facts concerning the power industry and making them public. Cooperation under the leadership of a central agency like the Federal Power Commission promises the nearest approach to 100 per cent success. The lesson may profitably be learned from the power industry itself: Like power systems, regulatory agencies must be interconnected, and this must be undertaken with the same purpose of betterment of service, namely, by decreasing the hazard of breakdowns and by promoting both economy and effectiveness of operation."

The Commission points out the increase of unregulated interstate power and proposes extensive studies of the engineering, economic and legal phases of the power problem, in which federal and state agencies and the power industry will need to cooperate, to establish "the basis of best and sound uses of our natural resources of water and fuel, with fair profits to the investor and lowest practicable costs to the consumer. The studies to be made must include a detailed and searching diagnosis of the problem confronting the industry and the estimates developed must be so workable and reliable that not only will the confidence of the industry and of the states be gained but the public insistence that regulation of rates he controlled by the facts established will also be met.

"Especially essential are statistics of cost, adequately standardized, properly itemized, and up to date, so as to inform the public and be of real service to the industry. Uniform methods of accounting and cost keeping are necessary if the records are to yield useful facts. At best, these facts are not to be obtained without a serious determination to go beneath the surface of things and an effort in good faith to learn the whole truth."

In a summary of the year's work the Commission lists the principal projects that have been brought to substantial completion and states that applications for major developments were received in about the same proportion as in previous years. Formal action was taken by the commission on 91 cases affecting the status of permits and licenses, in 32 of which licenses were authorized and in 11 of which preliminary permits were authorized, the remaining 48 involving a variety of actions, including amendment, termination, and transfer of licenses, and amendment of preliminary permits. Sixty-nine applications were referred to the three executive departments for investigation and 72 reports were received during the year.

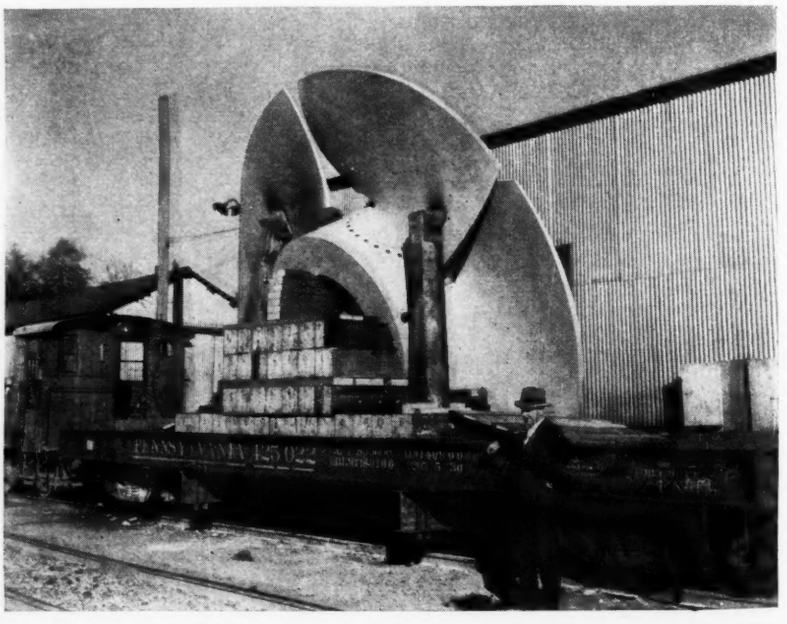
As a result of increased personnel in the accounting division, the commission reports that the work of checking the property investment or fixed-capital accounts is now nearer up to date than it has been for a number of years. Little, however, has been done by the accounting division in the way of checking the results of operation even of those projects as to which the investment has been established.

During the fiscal year 1931 the sum of $644,786.34 in license fees was collected, the report shows. A total of $2,529,434.67 has been collected in license fees from June 11, 1920, to June 30, 1931, and the total cost of administering the water power act during that time was $1,976,074.16, of which sum $744,492.82 represents direct expenditures by the Commission and $1,231,581.34 estimated expenditures by cooperating services.

Safe Harbor-Baltimore 220-Kv. Line Completed

THE LAST SPAN of cable was strung Dec. 1 by the Pennsylvania Water & Power Company on the first of the high voltage lines connecting the new $30,000,000 hydro-electric development at Safe Harbor with the system of the Consolidated Gas Electric Light & Power Company of Baltimore.

The new line extends for 70 miles through York County, Pa., and through Baltimore, Howard and Anne Arundel



Runner for one of six 42,500-hp. units to be installed at Safe Harbor, ready for shipment. It is 220 in. in diameter and weighs 124,000 lb. The hub contains the mechanism for adjusting the blades during operation at 109.1 r.p.m. under a gross head of 55 ft. Three of the units are being constructed by the S. Morgan Smith Company and three by I. P. Morris & De La Vergne, Inc.

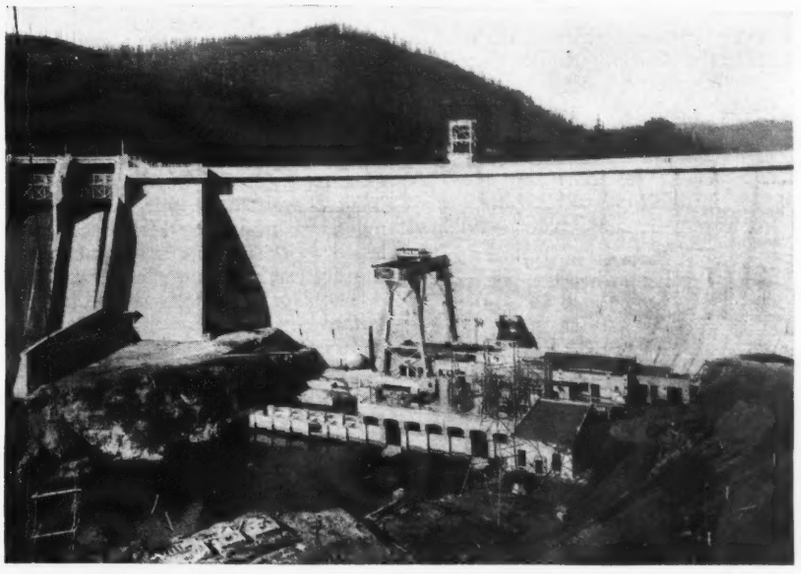
counties, Md. Its completion is in preparation for the delivery of power from Safe Harbor, which will be in service this winter.

Power from the river will be delivered at 220,000 volts. The new line circles Baltimore to the West before connecting with the system of the Consolidated company with which the Pennsylvania Railroad has contracted for power for all of its electrification requirements on its line between the Susquehanna crossing through Baltimore to Washington. The railroad will be supplied from a substation to be built between Baltimore and Washington.

The second of the railroad substations will be located at Perryville, Md. A transmission line carrying power at 132,000 volts will be built from Safe Harbor to Perryville. Safe Harbor will shortly be interconnected with the power development of the Pennsylvania Water & Power Company at Holtwood. Transmission lines from this plant connect with Baltimore, and the new supply will be in addition to Holtwood.

In Baltimore 33,000-volt cables will connect the steam stations of the Consolidated company and the terminal station of the new line from Safe Harbor with a frequency changer station to be built adjacent to the railroad substation.

ARIEL PLANT PLACED IN OPERATION



With its test period practically completed, the Ariel hydro-electric plant of the Inland Power & Light Company on the Lewis River, Wash., has been delivering power to the Northwestern Electric Company, Portland, Ore., which will operate it when it is turned over to the owner about the first of the year. The plant at present contains a 45,000-kw. generator direct connected to a 61,000-hp. vertical reaction turbine, operating on a normal head of 185 ft. The power house is built for two units, and foundations and penstocks are set for two additional units of the same size, which is the ultimate planned development at this point

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N. J. Engineers Start Public Works Program to Aid Idle

A STATEWIDE PLAN of municipal improvement is sponsored by a New Jersey Employment Committee of the American Engineering Council which has just been organized with Lynne J. Bevan of Montclair as chairman. The aid of the 2,800 licensed engineers and land surveyors in the state will be enlisted in shaping public works programs in every community.

These programs will be adjusted to a state plan, the legislature having provided that the state, to the limit of allotments, may meet, dollar for dollar, money paid by local political units for labor or personal services. Tasks ranging from city planning studies to road and street repairs and the remodeling of public and semi-public buildings are suggested. Elimination of grade crossings, the widening and beautifying of streets, plans and estimates for future highways and parks are other objectives.

The committee will also work with the Professional Engineers Committee on Unemployment organized in New York by the four Founder Engineering Societies to aid idle engineers throughout the metropolitan area. A New Jersey section of the latter committee has been formed with Louis A. Janny of the American Institute of Mining and Metallurgical Engineers as chairman.

The engineers, according to Chairman Bevan, purpose to stimulate sound construction work, and to avoid unsound projects. "The immediate objective upon which your action is requested," he said in an appeal to the engineers and surveyors, "is the bringing to light of sufficient amount of necessary public project work in your vicinity, and the incorporation thereof in the official plan of your community which must be filed with the State Director of Emergency Relief by Dec. 1, 1931."

Los Angeles Proceeds With 60,000-Kw. Steam Station

INSTRUCTIONS to report on a plan for construction of a 60,000-kw. steam generating plant by the City of Los Angeles, Calif., at Wilmington, a harbor suburb, were issued to a committee of the city's department of water and power recently by the board of water and power commissioners. The committee includes the department's general manager, chief electrical engineer and the city attorney.

Under the terms of an agreement between the city and the Southern California Edison Company, the city can not operate a steam plant until May, 1932. The department owns a site at Wilmington on which it is planned to locate the proposed plant. H. A. Van Norman, general manager, announced that engineers have been developing plans for the project for some time, in conformity with a resolution adopted by the water and power commissioners six months ago, and that construction would start as soon as possible.

International Standards For Petroleum Products

NATIONAL STANDARDIZATION BODIES of 21 leading industrial countries have been invited to participate in an international effort to secure greater uniformity in methods of testing petroleum products and lubricants under the auspices of the International Standards Association, according to a statement issued by the American Standards Association, to which the secretariat for the work was assigned by the international body. The invitations forwarded to the foreign standardizing bodies asked for the appointment of petroleum technologists as official representatives on an international committee to deal with the subject. The nomenclature of petroleum products will also be studied.

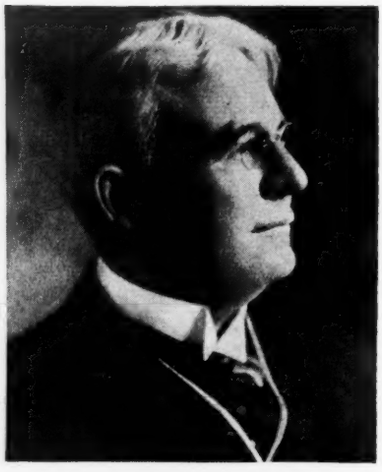
The widespread commerce between nations in gasolines and lubricating and fuel oils has made the need for international uniformity in nomenclature and in methods of determining the physical and chemical properties increasingly important during the past few years, according to the A.S.A.

Dr. R. P. Anderson of the American Petroleum Institute has been appointed as the American representative on the international committee. Dr. Anderson is also secretary of the American technical committee on nomenclature and methods of test of petroleum products and lubricants which has been working on national standards on this subject under the auspices of the A.S.A., with the American Society for Testing Materials directing the technical work.

H. T. Wickes, President of Wickes Boiler Co., Dies

HARRY T. WICKES, president of Wickes Brothers, the Wickes Boiler Company and the Arlington & Curtis Manufacturing Company, all of Saginaw, Mich., died on Nov. 20 in Pasadena, Calif., where he had gone for his health.

Mr. Wickes was born on Nov. 2, 1860, at Flint, Mich., where his father and his uncle, in 1856, had established



the machine shop and foundry which were moved to Saginaw in 1860 and became known as Wickes Brothers. He was largely responsible for the development of Saginaw from a lumbering town to an industrial city and was very well known in industrial circles. He was a member of the first board of directors of the Chamber of Commerce of the United States.

Ill health forced Mr. Wickes to retire from the active management of Wickes Brothers and the Wickes Boiler Company several years ago, although he had kept in close touch with their affairs. He had also been actively interested in several other companies in Saginaw.

Committee of Ten Holds Year-End Meet in Chicago

WITH EVERY cooperating industry except one represented the Committee of Ten held its final meeting of the year in Chicago, Nov. 23. The only group not represented was the Heating & Piping Contractors National Association, due to its delegate being called from the city.

Chairman J. H. Walker, of the research committee, presented a report covering current research in coal and its utilization and suggested that the committee might devote some attention to the use of coal in connection with the silica-gel system of air conditioning. The research committee was requested to assemble available data in that connection and make report for consideration at the next general meeting.

The appointment of a special committee was authorized to consider ways and means of conducting an exhibition of coal heating in connection with the annual meeting of the National Coal Association which is expected to be held next spring. The personnel of the committee is yet to be announced.

A resolution also was adopted requesting stoker and furnace industries to give study to the feasibility of developing stoker-furnace units or the development of equipment which might be combined to operate as a special unit with the highest possible efficiency.

The report of the local meetings committee showed that preliminary steps had been taken since the previous meeting for the organization of local cooperating groups in St. Louis, Cleveland and Pittsburgh, and told of plans for similar activities in Milwaukee, Knoxville, Louisville, Birmingham, Baltimore and Charleston, W. Va.

Manuals and study courses also were given considerable attention and the committee in charge of the work indicated that a preliminary program should be ready for the next meeting.

The membership committee announced acceptance by the National Association of Building Owners and Managers of the invitation to affiliate as an Advisory Member, and tentative acceptance of a similar invitation by the National Association of Power Engineers. Both organizations were represented at the meeting.

By unanimous vote Chairman Glover was authorized to call the next meeting of the Committee at Cleveland in conjunction with the annual convention of the American Society of Heating & Ventilating Engineers, Jan. 25 to 29.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Big Win, Ont., Canada, June 27-July 1. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Annual meeting and exposition, Hotel Statler, Cleveland, Ohio, Jan. 25-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association, Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

Seventh Annual Conference on Welding, to be held by the Engineering Extension Department of Purdue University at Lafayette, Ind., Dec. 10-11. Professor in charge, W. A. Knapp, Engineering Extension Department, Purdue University, Lafayette, Ind.

First Two 50,000-Hp. Units Completed at Beauharnois

WITH FULL-SCALE operations underway all year, the Beauharnois power development approaches the winter with three-quarters of its construction completed. Thus the work is still ahead of schedule. It is understood total costs are well in line with the estimates. To date the corporation has encountered no difficulties or problems which have delayed the construction. Before the resumption of active operations this year the large-scale construction equipment, representing an investment of nearly $5,000,000 was reconditioned. All season the equipment has operated at its maximum efficiency.

The power house was finished in October when the roof went on the plant. Installation of the first two 50,000-hp. water wheels has been completed and the third and fourth turbines are now being installed. The work of installing the generators for these units is underway.

In the movement of material, the corporation has made substantial progress. So far about 90 per cent of the rock excavation required for a 500,000-hp. installation has been completed. The tailrace has been completed and the water of the St. Lawrence has been admitted and now covers the draft tube outlets. The remaining rock excavation consists of sub-aqueous work connecting the tail race with the deep water of the river. Work on the main canal dykes is three-quarters finished.

K. G. Matheson, Head of Drexel Institute, Dies

DR. KENNETH G. MATHESON, president of Drexel Institute, Philadelphia, Pa., died of a heart attack Nov. 29 at his home in Bryn Mawr. He was 67 years old.

Dr. Matheson was born in Cheraw, S. C. He studied at South Carolina Military Academy, now Citadel College, and received his M. A. degree at Stanford University. He also studied at the University of Chicago and Columbia University.

After teaching at Georgia Military College and the University of Tennessee, Dr. Matheson became professor of English at the Georgia School of Technology, of which he became president in 1905.

The growth of Georgia Tech under Dr. Matheson led to his being called to Drexel Institute in 1922. Progress along all lines was noted during his administration. One of Dr. Matheson's important contributions was the extension of the cooperative plan of education so that about 200 of the leading manufacturing establishments, public utilities and mercantile firms of the greater Philadelphia area are working with Drexel in its five-year cooperative engineering and business administration courses.

Personals

PAUL S. CLAPP has resigned as managing director of the National Electric Light Association to become vice-president of the Columbia Gas & Electric Corporation. Mr. Clapp has been managing director of the N.E.L.A. since October, 1926. His successor has not yet been announced.

A. CRESSY MORRISON, whose services as secretary-treasurer of the International Acetylene Association for the past 25 years have been of incalculable value to the acetylene industry, was presented with the Morehead Medal for 1930 at the recent convention of the association in Chicago.

C. M. BREWER, vice-president and general manager of the Mountain States Power Company and the California Oregon Power Company, has been elected president of those companies to succeed JOHN J. O'BRIEN, who as president of the Byllesby Engineering & Management Corporation and the Standard Gas & Electric Company, has also served as president of most of the affiliated companies. Other recent elections include M. D. FIELD as vice-president and treasurer, J. C. BOYLE as vice-president in charge of operation, and GLENN L. JACKSON as vice-president in charge of sales of the California Oregon Power Company; and of W. L. FITZPATRICK as vice-president and treasurer, and Z. E. MERRILL as vice-president in charge of operation of the Mountain States Power Company.

JAMES J. RYAN, mechanical development engineer of the Westinghouse Electric & Manufacturing Company, has become professor of mechanical engineering at the College of Engineering, University of Minnesota, Minneapolis.

GEORGE M. RICHARDSON, purchase engineer of the Southern California Edison Company and president of the National Association of Purchasing Agents, has been appointed by the American Standards Association as its local representative in Los Angeles. Mr. Richardson will act as the point of contact between the industries of Southern California and the A.S.A.

EDWARD H. TENNEY, chief engineer of power plants of the Union Electric Light & Power Company, St. Louis, Mo., has been appointed chairman of the Power Committee of the St. Louis section of the American Society of Mechanical Engineers for the coming year. Other members of the committee are: JESSE L. BEST, station supervisor of the Cahokia plant, Union Electric Light & Power Company; ARTHUR K. HOWELL, president and treasurer of the A. K. Howell Company; and FRED O. PAHMEYER, vice-president of the Heine Boiler Company, subsidiary of Combustion Engineering Corporation.

How's Business?

IT INVOLVES no serious strain on one's optimism to see in the current statistical straws some signs of stabilization in the level of domestic business activity and some promise of improvement in the next 90 days. The October bulge in commodity and stock prices as well as in some business indicators was in larger part wiped out during November, but on the whole there has been no serious set-back, and some net gain. Steel activity and carloadings have succumbed very slowly to the usual seasonal slackening, and some stimulus to steel is still to be expected from year-end new-model automotive demand. The heart-breaking bond market is the outstanding and disturbing exception to this promising picture; and the accompanying banking strain and slackness in new capital issues must be overcome before we can count on a clear track for recovery.

The Business Week, Dec. 9.

Business Notes

ASHTON VALVE COMPANY, Cambridge, Mass., announces the appointment of Edward C. Kenyon as Pacific Coast representative, with headquarters at 606 Howard St., San Francisco, Calif., where he will be in charge of sales of the railroad and industrial departments. Mr. Kenyon was located previously at the company's Chicago office.

ARMSTRONG MACHINE WORKS, Three Rivers, Mich., started publication in November of a monthly house organ, *The Armstrong Trap Magazine*, devoted to the latest developments and practice in the steam-trap field. It is planned, the company announces, that each issue will carry a feature article dealing with the proper application of traps to specific classes of equipment, such as unit heaters in the first issue. Copies of the magazine may be obtained free of charge by writing directly to the company.

WICKES BOILER COMPANY, Saginaw, Mich., announces the installation of a modern X-ray machine and complete laboratory facilities, with the necessary equipment for fabricating welded pressure vessels and power boiler drums in accordance with the A.S.M.E. fusion welding code.

WORTHINGTON PUMP & MACHINERY CORPORATION, Harrison, N. J., announces the following changes in its sales personnel: George B. Cumming, for the past 21 years with the General Electric Company, has been appointed manager of sales of the resale and meter divisions; Carl F. Oechsle, formerly with Metaweld, Inc., has been made sales manager of the contractors' division; Charles A. Hirschberg is now in charge of rock drill sales and service; John J. Summersby, Jr., has been appointed assistant sales manager in charge of resale activities; E. E. Hoffman has been added to the New York sales staff as assistant manager; E. S. Hiley and E. C. Stewart have been added to the sales staff of the rock drill division.

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Trade Catalogs

CENTRAL STATIONS—Volume Seven in the reference series on "Modern Central Stations" has just been issued by the Ingersoll-Rand Company, 11 Broadway, New York, N. Y. It comprises eight illustrated articles, reprinted from the leading power magazines, describing in detail the following new central stations: The Gilbert Station, Station "A" (Pacific Gas & Electric Company), Shuffleton Steam Power Plant, Plant Atkinson, Minnesota Valley Steam Station, Louisiana Station, Belle Isle Station and St. John Power Station.

VALVES — The following illustrated bulletins have just been issued by the Apex Regulator Company, subsidiary of the Fisher Governor Company, Marshalltown, Ia.: No. 205X on A.S.M.E. standard pressure-relief valve; 210X on direct-flow relief valve for non-corrosive fluids; 305X on pressure control for water-cooled condensers in refrigeration systems; 315X on automatic ammonia expansion valves for refrigerating systems; 320X on ammonia back-pressure valve; 410X on combination pressure and vacuum relief valves.

PUMPS AND TUBES—Two new bulletins have been issued by the Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa. Bulletin No. 17-A covers in detail gear pumps for industrial and power plant use, while Bulletin No. 11-S describes and illustrates "Radiafin" tubes and pipes for heating and cooling equipment.

MOTORS — Construction features of Type T two-pole direct-current motors are described and illustrated in Bulletin No. 210 just issued by the Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio.

HOISTS AND CONVEYORS—Condensed Catalog No. 15, just issued by the Wright Manufacturing Company, Bridgeport, Conn., briefly describes the company's line of hoisting and conveying equipment, including hand-operated chain hoists, trolley hoists, traveling cranes, jib cranes and electric hoists.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Davis — University of California, Berkeley, will build a 1 story sub-station here by owner's forces.

Calif., Long Beach—City awarded contract for construction of sewage system including necessary structures and pumping stations to Gogo & Rados, 10024 Figueroa St., Los Angeles, $724,862.

Calif., Signal Hill—City Council, will receive bids until December 21 for construction of sewage disposal plant, including three pumping stations, filter and sludge beds, etc. Estimated cost $70,000. Currie Engineering Co., Andreson Bldg., San Bernardino, is engineer.

Calif., Upland — Upland Citrus Association, awarded contract for cement work for pre-cooling plant to W. E. Cline, 895 Washington Blvd., Upland, machinery to Carbondale Machine Co., 1031 South Broadway, Los Angeles, and cork insulation to Mundet Cork Corp., 461 8th Ave., New York, N. Y. Estimated total cost $60,000.

Conn., South Manchester—L. T. Wood, 51 Bissell St., receiving bids for construction of a 1 story, 62 x 125 ft. ice plant, including loading platform at Bissell St. and Johnson Terrace. Estimated cost $75,000. Frick Co., Inc., Waynesboro, Pa., are engineers.

Ill., Collinsville—City will probably receive bids in 1932 for construction of a sewage disposal plant and pumping station. Estimated cost $265,000. L. B. Kinsey, Marshall Bank Bldg., Pekin, Ill., is engineer.

Mass., Brighton (sta. Boston)—Boston Food Products Co., 532 Commonwealth Ave., having preliminary plans prepared for construction of a cooling plant. Estimated cost $50,000. Private plans.

Mass., Medford—Park Commission, c/o Wilton Fay, plans construction of an ice hockey rink. Estimated cost to exceed $25,000. Private plans.

Mass., Palmer — Commonwealth of Massachusetts, Dept. of Mental Diseases, State House, Boston, awarded contract for construction of boiler house at Monson State Hospital, to P. A. Cassidy, 43 Boylston St., Fitchburg, $105,500. Also electric work and equipment to Lord Electric Co., 303 Columbus Ave., Boston, and coal handling equipment to Colwell & McMullin, 31 St. James Ave., Boston, $24,875.

Mich., Lansing—City plans construction of sewage treatment plant including pumping station motors, pumping equipment, mains, etc. Estimated cost $100,000. S. F. Jacka, City office, North Capitol Ave., is engineer. Maturity about summer, 1932.

Minn., St. Paul—U. S. Engineer's Office, War Dept., Washington, D. C., receiving bids for construction of a power house at Twin City locks.

Minn., Spring Valley—City will receive bids until December 15 for construction of electric power plant and distribution system to include power house and three Diesel generating unit, 675 hp. capacity. Estimated cost $25,000.

Mo., St. Charles—Wayne S. O'Neal, Mayor and City Council, have retained engineering firm of Russell & Axon, Roosevelt Bldg., St. Louis, to construct a preliminary survey for municipal light and power plant here. Estimated cost $200,000 to $400,000.

Mo., St. Louis—City Water Dept., will probably receive bids early in 1932 for alterations to boiler plant including new boilers at Chain of Rocks waterworks plant on Mississippi River, $400,000. J. B. Dean, 1640 South Kingshighway, is division engineer.

Mo., Springfield—Treasury Dept., Office of J. A. Wetmore, Acting Supervising Architect, Washington, D. C., received lowest bid for constuction of a group of buildings to include 44 x 68 ft. boiler house, etc., at Hospital for Mental Delinquents here, from Joseph A. Holpuck Co., 401 West Madison St., Chicago, Ill. $1,676,000.

N. Y., Plymouth—Leon T. Stewart, c/o Town Clk., plans construction of electric light and plant and distribution system in Chenango county.

N. Y., Wallkill—Dept. of Water, Gas & Electricity, Municipal Bldg., New York, having revised plans prepared and will receive bids in May or later for waterworks pumping plant and equipment. Estimated cost $800,000.

O., Cleveland—American Construction Co., 1276 West Third St., Gen. Contrs., awarded subcontract for pumping plant and galleries in connection with Easterly sewage treatment plant on East 140th St., to Dawson & Finan, 1276 West Third St. for City of Cleveland.

O., Galion — City plans additions to boiler room at municipal light and power plant. Estimated cost $175,000. Hadlow, Hughes, Hick & Conrad Inc., 850 Euclid Ave., Cleveland, are engineers.

O., Oberlin — Oberlin College, c/o Ernest Hatch Wilkens, Pres., plans construction of Hall memorial building and heating plant. Estimated total cost $1,300,000. Cass Gilbert, 244 Madison Ave., New York, is architect.

Okla., Shawnee — City having preliminary plans prepared for construction of Diesel engine power plant for water plant and street lighting system. Estimated cost $75,000. T. E. Thompson, Shawnee, is engineer.

Pa., Cresson—State Tuberculosis Sanitarium, will receive bids until December 9 for boiler plant improvements, also construction of underground gas and electric lines. Estimated cost $50,000. Charles A. Blatchley, Drexel Bldg., Philadelphia, is engineer.

Pa., Lancaster — City, T. Warren Metzger, Mayor, will receive bids until December 15 for construction of sewage system and pumping station. J. N. Chester Engineers, 717 Liberty Ave., Pittsburgh, are engineers.

Pa., Rostraver—U. S. Army Engineers, Keenan Bldg., completing plans and will soon receive bids for construction of two power houses and one administration building. Estimated cost $34,000. Major W. D. Styers, Keenan Bldg., is engineer.

Texas — Central Texas Hydro-Electric Co., Sequin and Burnet, has acquired all properties including dam under construction in Burnet and Llano counties and sites for five other proposed dams on Colorado River formerly owned by Emery Peck & Rockwood Development Co. Estimated cost $8,000,000. F. A. Dale, Mgr., headquarters at Hamilton dam near Burnet.

Wis., Appleton—Lutz Ice Co., W. C. Jacobsen, Secy., 109 North Morrison St., awarded contract for construction of 2 story, 85 x 150 ft. ice manufacturing plant on Superior St., to Appleton Construction Co., 201 East College Ave., Appleton. Estimated cost $40,000.

Ont., Abitibi Canyon—Abitibi Power & Paper Co., 88 University Ave., Toronto, awarded contract for relays, controls, disconnecting switches, circuit breakers, lightning arresters, station service transformers, 500 kw. station service unit, voltage 132,000 in connection with hydro-electric power development on Abitibi River here, to Canadian General Electric Co. Ltd., 212 King St. W., Toronto.

Ont., Toronto—North American Life Assurance Co., 199 Bay St., will soon award contract for construction of a 15 story office building, including steam heating system, elevators, etc., on King St. Estimated total cost $1,500,000. Marani, Lawson & Morris, 38 Bloor St. W., are architects.

Que., Jonquiers—City will soon receive bids for addition to hydro-electric power house. Estimated cost $140,000 .

Equipment Wanted

Pump and Motor — San Francisco, Calif. — Constructing Quartermaster, Fort Mason, plans to purchase a 1,000 g.p.m. centrifugal pump and motor, etc., in connection with waterworks.

Transformers, Pumps, and Motors—San Francisco, Calif. — Board of Public Works, S. J. Hester, Secy., will receive bids until December 11 for furnishing and delivering power transformers, centrifugal pumps and synchronous motors in connection with Corral Hollow pipe line project.

Pumping Units—Boston, Mass.—Metropolitan District Commission, will receive bids until December 31 for one 50 m.g.p.d. and one 15 m.g.p.d. steam turbine driven centrifugal pumping units for Chestnut Hill pumping station No. 1.

Generating Units — Spring Valley, Minn. — Village Council, John Osterud, Clk., will receive bids until December 15 for three Diesel generating units for proposed power house.

Engine—Bay St. Louis, Miss.—Mayor and City Council, will receive bids until December 21 for removing present electric motor and installing gasoline engine with all accessories.

Boiler Equipment, etc.—Lebanon, O.—City, c/o W. C. Carson, Supt. of Plant, plans to purchase new boiler equipment with retort stokers and turbine driven fans for proposed improvements to municipal light plant. Estimated cost $24,000.

Switchboards, Panels, etc.—Wellington, N. Z. —Department of Public Works, will receive bids until April 5, 1932, for supply of distribution switchboards, panel switchboards, alarm panels and accessories for Waitak power plant.

Industrial Projects

Calif., Los Angeles—Los Angeles Soap Co., 617 East First St., awarded contract for first unit of soap factory, 2 story, 140 x 268 ft. at Vignes, Turner and Banning Sts., to Schuck Construction Co., 1937 West 62nd St. $65,000.

Calif., Stockton—Pacific Gas & Electric Co., 245 Market St., San Francisco, completed plans for construction of a 1 story meter shop here. Estimated cost $40,000. Private plans.

Ia., Cedar Rapids—Cedar Rapids Paper Box Co., R. L. Savage, Secy., plans a 1 story addition to factory at 1113 Sixth St. S. E. Private plans.

La., Meraux—Tex-York Utilities Corp., plans additions to and re-equipping of oil refinery. Estimated cost $1,000,000. Work will be done by day labor and separate contracts.

Mich., Wayne—Stinson Aircraft Corp., having plans prepared for a 1 story addition to airplane assembly factory on Michigan Ave. Estimated cost $50,000. Private plans. Electric motors will be required.

N. J., Newark—W. H. Jackson, 184 Broadway, New York, N. Y., Archt., receiving bids for construction of a 1 story, 160 x 220 ft. factory on Riverside Ave. here for Star Electric Motor Co., 140 Miller St., Newark. Estimated cost $40,000. I. DiStasio & Co., 136 Liberty St., New York, N. Y., are engineers.

Okla., Bristow—Marathon Oil Co. and Mid-Kansas Oil & Gas Co., Tulsa, plan enlargement of refinery plant at Bristow to include additional unit. Estimated cost $200,000.

Pa., Philadelphia—National Casket Co., 2043 Arch St., completed plans for construction of 4 story, 45 x 157 ft. manufacturing plant at 1519-21 Fairmount Ave. Private plans.

Pa., Warren—United Refining Co., H. A. Logan, Pres., plans to rebuild compressor unit destroyed by explosion. Estimated cost to exceed $40,000. Work will probably be done by day labor and separate contracts.

Tex., Jasper—Evans Products Co. Inc., Union Trust Bldg., Detroit, Mich., preparing plans for units 1 and 2 of crate and wood products plant, here, ultimate 12 units. Private plans. Machinery and equipment will be required.

Tex., Los Fresnos—Lion Leather Goods Co., c/o D. Petrie, Pres., plans construction of a 2 story, 40 x 90 ft. factory. Private plans. Equipment including stamping, cutting machines, etc., will probably be required.

Tex., Tahaka—Continental Chemical Co., Burt Bldg., Dallas, will soon receive bids for construction of a group of buildings for chemical plant to include evaporating building, pumping equipment, etc., here. Estimated cost $1,600,000